THE QUARTERLY REVIEW OF BIOLOGY

MARCH
1952

Vol. 27 No. 1

Published by
THE WILLIAMS & WILKINS COMPANY
BALTIMORE, U. S. A.

Copyright 1952
THE WILLIAMS & WILKINS COMPANY

THE QUARTERLY REVIEW OF BIOLOGY

FOUNDED BY RAYMOND PEARL

B. H. WILLIER, *Editor*
The Johns Hopkins University

H. BENTLEY GLASS
Associate Editor

CARL P. SWANSON
Assistant Editor

Advisory Board

IRVING W. BAILEY.....*Harvard University*
G. W. BEADLE.....*California Institute of Technology*
E. G. CONKLIN.....*Princeton University*
ROSS G. HARRISON.....*Yale University*
LIBBIE H. HYMAN.....*American Museum of Natural History*
A. L. KROEBER.....*University of California*
K. S. LASHLEY.....*Harvard University*
CHARLES W. METZ.....*University of Pennsylvania*
THOMAS PARK.....*University of Chicago*
G. H. PARKER.....*Harvard University*
ALFRED S. ROMER.....*Harvard University*
ALEX. G RUTHVEN.....*University of Michigan*
F. O. SCHMITT.....*Massachusetts Institute of Technology*
PAUL WEISS.....*University of Chicago*

Papers to Appear in an Early Number

RECENT ADVANCES IN OYSTER BIOLOGY
D. P. Korringa, *Government Institute for Fishery Investigations, Bergen-op-Zoom, Netherlands*

SOIL GENESIS AND THE PEDOGENIC FACTORS
Robert L. Crocker, *University of California*

THE INFLUENCE OF THE NERVE IN REGENERATION OF THE AMPHIBIAN EXTREMITY
Marcus Singer, *Cornell University*

Entered as second-class matter January 27, 1926, at the post office at Baltimore, Maryland, under the act of March 3, 1879
Subscription price $6.00 a year ($6.50 outside Postal Union) $1.75 a copy.
Made in United States of America

ZOOLOGY

By

ALFRED | M. ELLIOTT

FEATURES

- A principles text for beginning zoology, with emphasis upon organic evolution.
- Concentrates on broad biological concepts rather than on a study of minute detail.
- Uses man as the representative animal wherever possible.
- Places emphasis on modern concepts
- Original scheme of illustration, utilizing about 330 drawings never before used in a zoology text, and over 150 halftones.
- Written in a clear and challenging manner, pointed to the needs and abilities of college students.
- Well-adapted for use by general students as well as those who will continue their study of zoology.
- Maintains a high standard of scientific accuracy.
- Printed in two-column format; effective use made of typography.
- Annotated bibliography, classification of animal kingdom, glossary of zoological terms at back of book.

Appleton-Century-Crofts

35 W. 32nd St., New York 1, N. Y.

Accurate and Up to Date

Fascinating Reading

Medical MILESTONES

By **HENRY J. L. MARRIOTT, M.D.,** *Assistant Professor of Medicine, University of Maryland School of Medicine*

Foreword by SIR ALEXANDER FLEMING

Well-told stories you'll enjoy reading—and repeating—about the main advances in medicine in recent years: fascinating and dramatic, yet absolutely devoid of sensationalism.

Contents

BEWARE THE IMPOSTOR

THE MOLD ERA—Early Antibiotics

FIRST AND STILL FOREMOST—Penicillin

THREAT TO TUBERCULOSIS—Streptomycin

A TRUCE WITH TYPHUS AND TYPHOID—Chloromycetin

THE WIDEST RANGE—Aureomycin

BACTERIA AGAINST BACTERIA—Bacitracin and Polymyxin

MEDICAL SHRAPNEL—New Treatments for Anemia

HORMONES AND CANCER—Chemical Warfare on Malignancy

SPOILED SWEET CLOVER—Less of That Clotting

GOITERS SLOWED DOWN—The Anti-Thyroid Drugs

BLUE BABIES TO PINK—And Other Developments in Heart Surgery

ANIMAL FACTORS IN THE BLOOD—The Rh Story

FROM POISON GAS TO MEDICINE—British Anti-Lewisite

"IF ANYONE TOUCHES A LEPER"—Drugs and Attitudes

HOPE FOR THE RHEUMATIC—Cortisone and ACTH

"MILLION-MURDERING DEATH"—Cornering Malaria

ONCE BITING, TWICE SHY—Insects and DDT

MAL DE MER—Dramamine

ALL THAT GLITTERS

305 pp. *6 figs.* *$3.50*

THE WILLIAMS & WILKINS COMPANY

MT. ROYAL AND GUILFORD AVES. BALTIMORE 2, MARYLAND

(In writing to advertisers, please mention the journal—it helps.)

ECOLOGY

Official Publication of the Ecological Society of America

Continuing the Plant World

EDITORS

Botany
W. D. BILLINGS
University of Nevada
Reno, Nevada

Zoology
EDWARD S. DEEVEY, JR.
Osborn Zoological Laboratory
Yale University
New Haven 11, Connecticut

Established 1920 ***Quarterly***

Subscription, $7.50 a year for complete volumes (January to October, *inclusive*). Single copies $2.00 each, postpaid. Back volumes, as available, $8.00. *Postage extra on quantity shipments.*

Address all subscriptions or order for special issues to

DUKE UNIVERSITY PRESS

College Station P.O. Box 6697
Durham, North Carolina

REVISED and EXPANDED SECOND EDITION
THE

Author-Publisher-Printer Complex

By ROBERT S. GILL

Modifications made necessary by changes in production methods • More complete information on many points of importance • New chapter on literary property and inheritance • Complete rearrangement of material for more logical order • Addition of index to make material more accessible **153 pp. 9 figs. $1.50**

"Can be read with pleasure and profit by the most experienced and blasé writer."
—American Journal of Obstetrics and Gynecology

THE WILLIAMS & WILKINS CO.

Mt. Royal and Guilford Aves. **Baltimore 2, Maryland**

(In writing to advertisers, please mention the journal—it helps.)

Annals of Eugenics

A JOURNAL OF HUMAN GENETICS

Edited by L. S. PENROSE *assisted by*

JULIA BELL, R. A. FISHER, J. B. S. HALDANE, MARY N. KARN, R. R. RACE, J. A. F. ROBERTS

Vol. XVI. Part 4. May 1952.

Further data on genetics of microcythaemia or thalassaemia minor and Cooley's disease or thalassaemia major. I. BIANCO, G. MONTALENTI, E. SILVESTRONI, M. SINISCALCO.

Body weight at different ages and heights. W. F. KEMSLEY.

Blood groups in Jews from the Yemen. A. BRZEZINSKI, J. GUREVITCH, D. HERMONI, G. MUNDEL.

A Statistical study of human twinning. NORMA MCARTHUR.

Blood agglutinogens of the Mexicans. C. ARTEAGA, M. S. MALLÉN, A. V. BROZCO, ELENA L. UGALDO.

Simple tests for bimodality and bitangentiality. J. B. S. HALDANE.

Birth weight and length of gestation of twins, together with maternal age, parity, and survival. MARY N. KARN.

Data on the genetics of birth weight. L. S. PENROSE.

Reviews.

SUBSCRIPTION (payable in advance) *$9.50 per volume of four quarterly parts.*

Issued by the **CAMBRIDGE UNIVERSITY PRESS**

32 East 57th Street, New York 22, N. Y.

THE SERVALL ANGLE CENTRIFUGE

(SUPERSPEED)

Accepted and acclaimed by scientists throughout the world for its durability, safety features, smooth performance and efficiency. Our years of experience, and our pioneering of the high speed angle centrifuges guarantee their continued superiority.

Write for Bulletin R-31

Max. speed 13,500 r.p.m.
or R.C.F. 23,000 x G
Max. capacity 8 x 50cc

Ivan Sorvall, inc.

210 Fifth Avenue, New York 10, N.Y.

(In writing to advertisers, please mention the journal—it helps.)

VOL. 27, NO. 1 March, 1952

THE QUARTERLY REVIEW *of* BIOLOGY

"DERIVED" ACTIVITIES; THEIR CAUSATION, BIOLOGICAL SIGNIFICANCE, ORIGIN, AND EMANCIPATION DURING EVOLUTION

BY N. TINBERGEN

Department of Zoology, Oxford University

1. INTRODUCTORY; A BRIEF SKETCH OF THE ETHOLOGY OF INSTINCTS

THIS paper is an attempt at an explanation of certain types of behavior, many of them elements of threat, courtship, or other types of display, the origin of which has long been obscure, but is now gradually becoming known. The attempt is based on our knowledge of the nature of innate behavior, which gradually is emerging through the work of K. Lorenz and his collaborators. It is necessary to present a short sketch of what we know about innate behavior in general before attempting to apply this knowledge to the phenomena here collectively named "derived activities." This sketch will be necessarily summary. For a fuller treatment I must refer to various papers by Lorenz (1935, 1937, 1943, 1950) and by myself (1942, 1950), and to my book on *The Study of Instinct* (1951).

Part of this paper, particularly the section on the analysis of displacement activities, is a revised English edition of a paper written in German (Tinbergen, 1940). The present paper takes some new facts into account and gives new, and I think more correct, interpretations of some problems which were treated unsatisfactorily in 1940.

The starting point of all theories on instinct has been the everyday observation that animals perform movements that contribute, often in an amazingly refined way, towards maintenance of individual, group, or species. The first steps toward understanding are two obvious, though largely negative conclusions: (1) Many of these behavior patterns need not be learned, but are entirely or largely innate; they are often performed in full by individuals reared in isolation, who cannot have had opportunity to learn them; and (2) innate behavior may "go wrong," that is, miss its objective, without the animal doing anything to correct itself. Such observations show that the animal has no "insight," or very little, into the relation between its behavior and the result obtained. Because we human beings like to believe that our own behavior is entirely guided by insight or knowledge of this type—a widespread fallacy due to overestimation of "reason"—the spectacle of behavior going wrong impresses and puzzles us.

These considerations make us realize that animal behavior cannot be explained anthropomorphically. The behavior of animals puzzles many of us *even more* than our own behavior, and this leads us to the basic problem: what causes the innate, and yet so effective, behavior of animals? Briefly, present knowledge amounts to the following.

Behavior, with very few exceptions which need not concern us here, is coordinated muscular movement. Each contraction of skeletal muscles is the effect of stimulation by motor nerves—again, with very few exceptions which are irrelevant for the present purpose. The impulses passed on by motor nerves towards the muscles come from the central nervous system. The coordination, or patterning, of muscular movements is largely due to patterning of the impulses leaving the central nervous system. The central nervous system perhaps discharges these impulses in part spontaneously, on its own accord; it further acts in response to stimuli either from the outside (usually impinging upon the animal through its sense organs) or from within. Such agents from within are in some cases hormones, in other cases internal sensory stimuli. These internal factors, sometimes together with external stimuli, activate a "drive" or an "urge" in the animal. We know now that behavior is rarely pure "reaction." The readiness to react to certain releasing stimuli varies in time, according to the degree of activation of the drives. The internal factors are more or less specific; for instance, sex hormones activate the reproductive drive but not the feeding drive. An activated drive causes specific searching behavior; the animal starts "spontaneously" and searches until a situation is found which provides the specific stimuli releasing end-activities belonging to that drive. For instance: a hungry duck hawk starts searching for prey spontaneously; it is then susceptible to the sight of prey, but not, or less so, to the sight of a mate. The stimuli provided by a flock of teal release a specific response belonging to the feeding drive: actual attack.

I have used the term "spontaneous" with reference to two different systems. When I said that an animal often acts spontaneously I meant that the factors responsible for action are not outside stimuli but internal factors; I referred to the animal as a whole. When I said that the central nervous system probably acts spontaneously, this was meant to say that the internal factors causing the central nervous system to discharge its motor impulse patterns need not always be factors outside the nervous system, such as hormones, but may in part be active within the central nervous system itself. "Spontaneity" of the animal as a whole is an established fact; "spontaneity" of the central nervous system, a part of the animal, has not been proved, though it seems probable.

In studies on animal behavior one often meets with the idea that certain movements are due to "general excitement." I think it is very doubtful whether excitement (by which is usually meant readiness to act) is ever really general, that is, affects all drives equally. If the evidence upon which such assertions are based is scrutinized critically, it is clear that there is no question of all the drives being activated at the same time. Almost always the increased readiness to act is confined to either fighting, or mating, or feeding, or escape. It is true that sometimes fighting and mating and even all the other reproductive drives are activated at the same time, but then the non-reproductive drives are in a state of low activation. And since we know (Hess, 1944) that sleep is also dependent on a drive, on activity of certain parts of the nervous system, the term "general excitement" is even more absurd, for if it were general it would affect sleep as well. An animal, "excited" in this general sense, should go to sleep more easily than under conditions of lower "general" excitement, and this is contrary to the observed facts. Excitement can be more or less specific, or less or more general, but there is a limit, and only rarely is more than one drive activated.

Because now one drive, now another may be activated in an animal, we need a word to indicate this state of activation and to relate it to the drive. For this I will use the words "motivation" and "motivated," following American usage. As an equivalent of the lengthy expression "the sexual drive of the animal is activated" I will say "the animal is sexually motivated." This motivation may be strong or weak.

The specificity of the drives has led to the concept of "reaction specific energy." This concept has aroused criticism from various sides. It would lead too far to discuss this problem here; I merely want to stress that "reaction" should be understood in its widest sense, as "behavior pattern." It may, but it need not, be a simple movement, it may be mere "readiness to act," and it must not be pure reaction but "action-and-reaction-in-one." For these reasons the term "drive-specific energy" would be preferable; some use the term "specific action potential."

Concluding, it is a matter of simple observation that an animal is often driven to action from within, and that this inner urge or drive can be of different kinds, each giving rise to a different be-

havior pattern. It is this fact, the specificity of drives, which is to be kept in mind when an attempt has to be made to explain behavior, especially of the type usually termed displacement activities (with which the greater part of this paper is concerned).

The various drives of an animal are always fluctuating in strength. They are, if strongly activated, mutually exclusive: the animal usually does "one thing at a time." That is to say, however variable its movements may be, even from one second to the next, there is usually some consistency: once a drive has been strongly aroused, the animal obeys it for some time, and is not likely to shift suddenly to another activity, unless forced to do so by a very powerful stimulus.

This consistency is, however, as a rule a matter of minutes, or hours. In the course of a day an animal does a variety of things: now the feeding drive is predominant, causing the animal to search or even to migrate for food, now the escape drive is activated, now the sleeping drive. Some of these drives show a regular daily or, in the case of the reproductive drive, a seasonal rhythm, others are usually "kept in reserve" until an overriding external stimulus releases them, as is often (though by no means always) the case in the fleeing drive.

This relatively simple system, of internal factors causing spontaneous search and increased readiness to respond to specific outside stimuli, gives rise to an amazingly varied repertoire of behavior. This variety is due to a number of circumstances which are to be kept in mind continuously during a study of behavior. Some of these complications are:

(1) *Hierarchy.* Each drive is a hierarchical system, divided in subordinated drives of a more restricted type than the general drive. For instance, the reproductive drive of most birds, if activated, controls a number of activities: courting, mating, defence of territory, nest-building, incubation, etc. There is definite order in these activities. The first result of the activation of the reproductive drive in a male passerine bird, for instance, is migration towards the breeding area. Such directed, preparatory behavior, leading to a special situation, is called appetitive behavior. When a suitable territory is reached this appetitive behavior comes to an end, and the bird begins to sing with full force. He roams around the territory on the lookout for females and for intruding males. He is ready to react to both, but with different behavior patterns. As soon as he spots an intruding male, his fighting drive is released. If a female appears, his courting drive is released. Both these partial patterns, however different they may be, are kept in readiness; usually they can only be released by stimuli from the intruding male or the female, as the case may be. In addition, however, both are susceptible to release by these stimuli only because the major reproductive drive as a whole is activated.

The fighting drive, or subdrive, itself does not control merely one simple movement; it gives rise to a special form of appetitive behavior (flying aggressively towards the intruder) followed by one of several possible forms of aggression: posturing, attack, or chase. The form of aggressive behavior actually shown depends on the strength of the drive in the territory owner, and on what the other male does, which means, on which external stimuli impinge upon the attacking male.

These and similar facts show that the reproductive drive is a hierarchical system. The causal system underlying it is arranged in levels. Some factors are responsible for the activation of the reproductive drive as a whole. In male song-birds of our zone, sex hormones are among the internal factors; rise in temperature in spring, releasing migration, is one of the external factors. Once the reproductive drive is activated and migration has brought the bird into a territory, it is ready to react, by various subordinated patterns such as courting or fighting, to specific stimuli which have a more restricted effect than those releasing the reproductive system as a whole. When these more restricted stimuli have switched the bird into, say, attack, it reacts to still more specific stimuli by a special type of attack.

Again, I should like to stress the need to keep theory and fact well apart. While a theory evolved upon these facts, which might be called a "center-theory" and which will not be elaborated here, may be proven to be at least oversimplified, I do not think we can doubt the existence of a hierarchical organization of drives. For our present purpose it is sufficient to point out that, when a certain drive is activated, the behavior to be expected, though limited to movements belonging to that drive, can be of many different types. Which type is shown depends on which subdrive, and sometimes on which part of this subdrive, is activated. Thus it is obvious that in order to

understand the causal relationships underlying behavior it is necessary to know a variety of factors and their influence, factors acting on the various levels of the hierarchical system.

It is also possible to develop the same conclusion about the hierarchical structure in another way. I will take the incubation of eggs in the herring gull as an example. It has been shown by experiments that incubation in this species depends on external stimuli from the nest and from the eggs. The eggs stimulate by their being in the nest, and by their rounded shape. To these stimuli the bird responds by brooding, which is a special way of sitting upon them. The ventral feathers are ruffled, and by making waggling movements in a more or less squatting position the bird shuffles these feathers around the eggs, which are thus brought into contact with the naked skin. This response is dependent on the internal state of the bird as well: it must be "broody." From experiments with other birds we know that broodiness is a consequence of the presence of at least one hormone, prolactin. Now brooding is not the only reaction of a broody bird. When the arrangement of the eggs is disturbed, the bird reacts to the changed touch-stimuli which it receives while sitting on the eggs, by rising, bending its head down, and shifting the eggs with the bill. It then sits down again, and if the touch stimuli are still not satisfactory, it will shift the eggs once more. This is repeated until the eggs are well arranged. This reaction also is controlled by the internal state: again, only a broody bird does it. A third reaction is the rolling-in of eggs lying outside the nest-cup. Rolling is a reaction to a visual stimulus-situation, "egg outside the nest." This response is also controlled by the state of broodiness.

The striking point is that, although each of these three responses depends on a specific stimulus situation, they are all dependent on "broodiness" in general. Broodiness is the state into which the bird is brought by prolactin, and, probably, by some external stimulus as well, but the pattern to which it gives rise is varied, and consists of at least three types of response each governed by its own releasing stimulus situation.

(2) *Intensity.* The form of a movement shown in a certain situation may vary immensely with the variation in intensity of the drive. Although in some cases the responsiveness of an animal may be a matter of all or none, of eating or not eating, or of attacking or non-attacking, in most cases there is a gradation of intensities of response. This is easily seen when the various intensity stages differ in degree, as in the case of the loudness of an alarm call. A weak disturbing stimulus, such as a distant human being, releases in a herring gull a scarcely audible, high-pitched "hehe." As the intruder approaches the call will become gradually louder. Its pitch may change a little, also the number of syllables will increase from a mere two to four or five, but no observer has any trouble in recognizing the same call throughout. This however is rather the exception. Usually, increasing intensity will result in the addition of elements to the movement. Good examples can be seen in nest-building behavior. A newly mated female bunting, for instance, will show the first signs of the tendency to build by occasionally picking up a straw. On the first day, this will be all, and she will drop the straw almost immediately after picking it up. Next day, she may carry it along for some time. The day after that she may carry it for a longer time, and even go to a typical nesting place, but drop it there. With still growing intensity, she will carry it to a nesting place, and will begin to build. In this case, the gradation from the vestige to the more complete pattern facilitates interpretation as an intensity sequence. This is more difficult when the next higher intensity stage of a type of behavior consists in a radical change of response, as for instance when a crab, with growing lack of oxygen in the water, will change from normal breathing merely with increased frequency to "emergency respiration," which is quite a different pattern. Or, when we approach the nest of a European blackbird, the male will first give a soft but penetrating, long-drawn, squeaking call. When we approach more closely, it will change to the well-known repeated "tjook-tjook-tjook," which, upon still closer approach, will change into the loud, yelling "cheeng-cheeng-cheengcheeng-cheeng" and accompanying "nervous" movements, even a charge.

It is not only the motor pattern that changes, but also, as is well known, the responsiveness to external stimuli. Very hungry animals, or sexually very strongly motivated animals, will react to objects which would not evoke any response in a state of lower motivation. This may lead to reactions to inadequate objects, that is to say objects with which the biological end of the drive cannot be attained, such as inedible food, or females or chicks of different species, etc. When

a very strong drive causes an animal to react to suboptimal stimulus situations we may speak, following Armstrong (1950), of overflow activities. In extreme cases an activity may even be performed without the situation providing any of the normally required sign-stimuli at all, and then the term "explosions" or "vacuum activities" is used.

Thus variation in the intensity of the reaction may be due to variation of the strength of the drive. This in turn may be the outcome of variation in internal state, or of variation of the external situation, or (usually) both. Sometimes the variation of the intensity may be most obvious in the type of movement shown, in other cases in the degree of selectiveness towards external stimuli. Usually, we observe both.

(3) *Ambivalence.* The picture is further complicated by the occurrence of ambivalent behavior. Although very strong motivation leads to one type of behavior to the exclusion of all other types, moderate motivation may allow the animal to obey two drives simultaneously. If, then, the environmental situation offers stimuli acting upon parts of two different drives, a mixture of two behavior patterns may be the result. For instance, a female stickleback arriving in a male's territory evokes attack and courtship at the same time, and a mixture of incipient attack and incipient leading-to-the-nest is the result. A herring gull offered a red egg in the nest will be stimulated to brood it by its rounded shape, but the red color will cause it to peck at it, since it has the tendency to remove red objects from the nest. Such behavior may seem puzzling and unpredictable at first, but when one knows the brooding pattern and the reaction of carrying objects away from the nest, and also the optimal stimuli to which these two patterns normally respond, one is able to recognize the behavior as a mixture of two responses, and to explain it on the basis of one's knowledge of the effective environmental factors. As I will show below, one of the threat postures of the herring gull is such a mixture of two responses.

(4) Finally, variation in movement may be due to change in position of outside objects towards which the animal orients itself. For instance, a territory-holding male song-bird may shift its favorite singing tree. This may be taken as unpredictable behavior until one finds that a new neighbor settled close to the new singing post has absorbed the owner's aggressive attention and caused him to move.

Much of so-called "random behavior" is not random at all, but steered from step to step by outside stimuli. Herring gulls flying home over the irregular dune scenery do not follow a straight course, but a very irregular one. The deviations from the true course are governed to minute detail by the updraughts caused by the impact of the wind on the irregular sand hills. Consequently their route changes with changing wind. In these and many similar cases it is our lack of knowledge of the influential outside stimuli that makes the movements appear random. It is not a scientific method to bring forward unanalysed observations as a support of the alleged impossibility to explain behavior. The student of behavior should seek to explain behavior, and not to prove that it cannot be explained.

This outline of the causation of innate behavior, sketchy though it may be, is, I think, sufficient to demonstrate that the principles mentioned account for behavior of great complexity. It may also make clear that a thorough study of the manifold factors, internal and external, and of their influence on behavior under various conditions of motivation, is required before a conclusion about the adequacy of this outline is justified. Such a study, even if confined to one species, takes years. When it has been completed, it is surprising to what extent and in what detail one can predict the behavior, provided the circumstances are known. In the two species I know best, the herring gull and the three-spined stickleback, I can usually predict the behavior of any individual with fair accuracy. To mention just one instance: when a territory-holding male herring gull sees another male coming towards him, I can predict that he will stretch his neck, point his bill down, walk towards the intruder, and, upon reaching him, will peck into the ground and pull at moss or grass. If this fails to stop the intruder, the owner will attack him, by pecking at him and beating him with his wings.

This possibility of prediction—always the most decisive test of a theory—seems to me to be a most encouraging testimony of the value of this type of study. Of course it is impossible to say at present what gaps and errors it still contains; for such an evaluation we simply lack the necessary factual evidence. However extensive the data may be

which have been brought to light by Heinroth, Lorenz, and many others, we need still many more facts so that we may test the present tentative conclusions and if necessary change them. This, however, cannot be done on the basis of fragmentary, incidental, or superficial observations. A stage has been reached now at which systematic and thorough research, both observational and experimental, is required.

II. "IRRELEVANT" ACTS

Now, assuming that I have convinced the reader that following an intensive study of a given species the observer can predict what will happen under certain known conditions, he will appreciate the surprise one gets when the animal obviously acts contrary to the prediction. It is, for instance, contrary to expectation when two skylarks, engaged in furious combat, suddenly peck at the ground as if they were feeding; it is equally surprising when starlings during a territorial fight begin to preen their feathers, only to resume their fight a few seconds afterwards. It is "odd" when courting ducks suddenly interrupt their courtship to do some hasty preening, or when fighting herring gulls go through the motions of collecting nest material immediately after and immediately before an actual attack. The movements shown appear "irrelevant," entirely out of context with the behavior immediately preceding or following them. We are so used to what I have called above the consistency of behavior that such a sudden interruption without any obvious external stimulus, so contradictory to our general experience, comes as a challenge.

When such irrelevant behavior is observed once, it may be taken even by an experienced observer to be a result of an unaccountable, sudden shift in the kind of the animal's motivation, however surprising such a sudden and short shift may be. However, irrelevant acts occur often and in many species, and when a species is studied thoroughly it is soon obvious that there is a certain regularity in the occurrence of irrelevant acts; indeed, a given irrelevant act is often typical of a particular set of conditions.

The irrelevancy is found in the fact that although an animal is clearly in fighting motivation, or, in other cases, in mating motivation—in general, when instinct "a" is activated—and although we know by experience that we must expect movements belonging to the executive pattern of this instinct "a," we observe movements belonging to the executive pattern of another instinct, "b." The activity seems to be displaced from instinct "b," to which it belongs, to instinct "a" which uses it as if it were a part of its executive pattern. In my first paper on this subject (1939b) I used the term "substitute activity" already used by Kirkman (1937). Kortlandt (1940) invented the German term "Uebersprungbewegung." This could be rendered by Makkink's term "sparking-over," used in a slightly different context (1936). Since I was told by American colleagues that "substitute activity" had already a different meaning in psychology, and since "sparking-over" seemed a little clumsy, especially in composite terms, I asked Dr. Huxley, Dr. Thorpe, and Mr. Armstrong to provide me with a good English term, and they agreed on "displacement activity" (1946). This term has been in general use since then and it seems to me that it would be wise to stick to it even though, as Armstrong (1956) argues, it may not be ideal. The genuine activity, that is the activity when caused by its proper drive, has been called by Kortlandt the "autochthonous" activity. The displacement activity derived from it, that is to say the same activity when caused by another than its proper drive, may be called "allochthonous," but there is usually no need to use this term. The autochthonous activity from which a displacement activity is derived, is called its "example."

Before I discuss the causal study of displacement activities, a review of recorded instances must be given. In this review no attempt at completeness will be made; in fact I deliberately confine myself to such acts as have been observed repeatedly. For a fuller enumeration of records I must refer to Armstrong (1950).

Some instances of displacement activities

The aim of this section is to demonstrate the general occurrence and the variety of types of displacement activities, particularly for the benefit of those readers who are not acquainted with the phenomenon. I will arrange the instances according to the pattern to which they originally belong, irrespective of the circumstances that give rise to them. Also, I will describe "ritualized" as well as "pure" displacement activities, leaving the principle of ritualization to be discussed in a later section. Though this is rather an inelegant

way of introducing them, I prefer this presentation because it is the way in which nature itself presents them to the observer.

Foraging movements

When a lapwing is disturbed at the nest, it will not only call the alarm and attack the intruder, but now and then it will alight, run "nervously" about, and peck at the ground. Usually this pecking is incomplete, only the curiously stiff bending movement betraying its nature. When the disturbance is prolonged it may develop into complete feeding, and I have seen a lapwing in this situation actually catch a worm and eat it.

A grey heron male, upon its return to the breeding colony in spring, selects a suitable nesting place in a tree. Here it begins to utter its "love call," which is true song, expressing sexual motivation and exerting an attractive influence on females. This love call is alternated with "snapping" (Fig. 1). "This is a very curious movement. The neck is stretched and the head is lowered to the level of the feet or even lower, when the bird bends its legs. When the head is at its lowest, the bird opens its bill and then shuts it with a loud clash. The feathers of the crest and neck are erected during this ceremony" (Verwey, 1930: 23–24). Verwey believes that "the fish-seizing movement has been put into the service of the love-life" (p. 25). This snapping is only done by the male, and only when it is under the influence of a strong sexual motivation.

Snow bunting males in spring alternate fighting and threat with pecking at the snow-covered ground during boundary clashes. The same pecking movements are shown by the male when the female refuses copulation. This, in the early phase of mated life, leads to a "sexual flight" (Howard, 1929). Pecking movements appear before or after a sexual flight. They are just as incomplete as those shown during fighting. In the courtship they may alternate with sexual display, in which the male shows off its beautiful black-and-white dorsal plumage (Tinbergen, 1939a).

According to Pickwell (1931), the prairie horned lark shows food-pecking during boundary disputes. Pickwell describes this behavior in the following words: "Now and then they will approach each other in this attitude and peck away at the ground furiously, like two cock roosters in an intermission of battle" (p. 56). The similar behavior of domestic cocks, referred to here, is of course well known; it is also mentioned by Lorenz (1935). Pickwell's characterization "furiously" refers to a phenomenon which I shall discuss further below.

Both the great tit and the blue tit show displacement eating during territory clashes. They will peck energetically at the twigs on which they happen to be sitting, or they will even select buds and tear them apart (Tinbergen, 1937; Hinde, 1952).

Avocets show a variety of displacement activities during fights. According to Makkink (1936): "Sometimes the bowing before fighting [bowing is displacement nest-building, N.T.] is interrupted by a furious throwing of straws—especially in encounters on the land, but even in the water—and by water-pecking and shaking of the head or also by a fierce food-mowing—principally when in the water" (p. 18). While in some of the species mentioned previously the incompleteness of the movement often renders it difficult

FIG. 1. MALE GREY HERON "SNAPPING"
After Holstein, 1927.

to be certain that we have to do with feeding movements, the specialized "food-mowing" of the avocet is easily recognized as such even if it is incomplete.

Both displacement eating and displacement drinking have been observed numerous times in a male turkey by H. Räber (1948, p. 253): "When both the fighting and the fleeing drive were activated, it pecked imaginary food from the ground or showed a tendency to drink. In this case it sometimes went to the drinking cup and dipped the bill into the water, without actually drinking however." Displacement drinking has also been observed by Armstrong (1950, p. 369) in a female eider duck, which was disturbed at the nest.

In animals other than birds there seems to be little evidence of displacement feeding, though occasional observations have convinced me that it is not uncommon in ruminants during aggressive encounters (Tinbergen, 1940). The threat posture of three-spined sticklebacks, originally interpreted by me (ibid.) as displacement-feeding

later proved to be displacement sand-digging, a nest-building activity (see Tinbergen and Van Iersel, 1947). The wrong interpretation was due to the fact that for years we failed to see the high-intensity forms of this movement. These, as a matter of fact, appear only under abnormally crowded conditions, and until we had provoked these, we merely observed a vertical posture accompanied by an energetic budding into the ground. Somehow it did not occur to us that this might be displacement sand-digging. The more intensive movement, however, does not leave any doubt as to its origin, because sand is then actually taken up and carried away.

Movements of care of the body surface ("comfort-movements," McDougall)

The various movements belonging to this system (preening, shaking the plumage, wiping the bill, bathing) are also frequently used as displacement movements in a variety of situations. Fighting starlings may stop now and then and preen their wings in a "nervous" fashion. Many if not all species of cranes do the same (Lorenz, 1935). In many ducks displacement preening is a regular constituent of courtship by the drakes (Lorenz, 1941); the sheldrake always preens its wings just before coition (Makkink, 1931). Fighting snow bunting males alternate displacement-feeding with preening under the wing or in the scapulars (Tinbergen, 1939a). According to Makkink (1936, p. 13) the precoition behavior of the avocet consists of long bouts of preening: "The plumage preening by both members of a pair, connected with and interrupted by the dipping of the bill into the water, always precedes copulation" (Fig. 2). In pigeons displacement preening has a similar function. Many species preen the wings preceding coition, as described at length by Craig (1909), Whitman (1919), and Carpenter (1933). Kortlandt (1940b) reports that cormorants, when alarmed by human visitors, ruffle and shake the plumage when the danger is over.

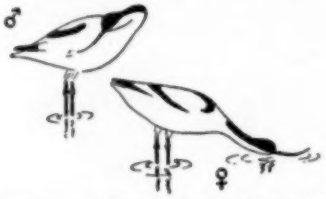

FIG. 2. PREENING AS PART OF THE PRECOITION DISPLAY IN THE EUROPEAN AVOCET
After Makkink, 1936.

Various birds have been observed to displacement bathe. If, in a pair of shelduck, the copulation breaks off halfway, both partners may begin to bathe (Makkink, 1931). Armstrong (1950) reports displacement bathing in black-headed gulls disturbed at the nest. In the same situation that induces displacement-shaking in cormorants. Kortlandt observed displacement-bathing as well.

In various birds of paradise bill-wiping is a regular constituent of the males' courtship (Armstrong, 1950; Tinbergen, 1940).

Scratching the fur has been observed in various primates when they are in some way frustrated (Portielje, 1939, in the orang utan; Tinbergen, 1940, in the chimpanzee). In man, various movements belonging to the same group of activities may be observed under conditions of stress: scratching behind the ear, biting the nails, in women various kinds of arranging the hair, etc.

Nest-building movements

Geese and swans of various species are known to dip their heads and necks into the water before coition (Heinroth, 1911). This has been interpreted in various ways. Makkink, for instance, has suggested that in the sheldrake it might be a bathing movement (1931). Lorenz discovered that the birds occasionally bring up vegetable material from the bottom, which they sometimes deposit at their side with a sideways head movement. This shows that we have to do with nest-building movements.

In boundary clashes herring gulls may take up nest-material, and throw it away with similar lateral head-movements. Sometimes they select strongly rooted plants that offer resistance and pull at them (Fig. 3). This grass-pulling, as well as another activity derived from the nest-building pattern ("choking"), will be discussed more fully in the analytical section.

Nest relief in herring gulls often brings about displacement activities in the relieving bird, especially when the partner is not willing to leave. The relieving bird may then bring nest-material; it may also "choke." The relieved bird may bring some nest-material as well; it may even collect it rather far from the nest and bring a load to the nest more than once.

Kirkman (1937, pp. 78–79) gives an interesting description of similar behavior in the black-headed gull. He reports that much of the building activity seen after incubation has started is not autochthonous building but displacement building. "A considerable number, if not most, of the additions are made owing to causes quite unrelated to the building of the nest, they are due to a substitute reaction, by which is here meant a reaction substituted for one that is prevented from taking place." "The occasion is the return of a bird to its nest. It is feeling broody and is eager to sit on the eggs, but its mate is in occupation and refuses to budge. It tries to get the mate off by wedging itself under its breast, by pushing its foot against the immovable flank, by calling notes, by sitting on the back of the sitter. It is all no use; there is complete obstruction.

"When this happens it is predictable that the frustrated bird, unable to satisfy its brooding urge, will find relief by substituting for incubation some reaction associated with the situation, usually gathering nest material. The following are two instances, and they could be multiplied." One of these instances may be quoted: "A returning bird, on being refused the eggs, went in search of nest material; it returned, dropped a weed on the margin of the nest, then tried to push the sitting bird out with its foot. This failing, it stood, beak downwards, uttering the crooning call note used to summon chicks or the hen to the food. As this also failed, the bird again went collecting; it returned without anything, again tried the effect of the call note, and again departed. It came and went twice more. The second time it appeared with a single short stalk projecting from the corner of its mouth, with a comic resemblance to a toothpick. It found the nest vacated, whereupon it dropped the stalk into it and settled down."

If the urge to brood is not quickly satisfied, therefore, the black-headed gull, like the herring gull, makes nest-building movements. Kirkman's report differs however from that on the herring gull in that he mentions a call "summoning chicks or the hen to food." As I will discuss later, I am inclined to believe that Kirkman here fails to distinguish between "choking" and feeding chicks or the hen; I rather think that he observed the equivalent of "choking."

Nest-building behavior as a component of nest-relief is found in many related species, such as terns and waders. Both the relieving partner, walking towards the nest, and the relieved partner may pick up straws, pebbles, or shells, and throw them sideways. This movement is seen in a more complete form during actual nest-building in some species. When nests are in grass it serves to line them with the surrounding grass-shoots. Species nesting on the sea-shore usually pick up pebbles, shells, rabbit droppings and other odd objects that happen to lie around, and when, as is often the case, it is mainly the relieved bird which picks them up and throws them backwards, they gradually gather round the nest. As we will see later, it seems that in some species, for instance, the oystercatcher, this movement is always a displacement activity. The autochthonous "example," which is found in many waders, seems to have been lost in this species.

FIG. 3. "GRASS-PULLING" IN THE HERRING GULL DURING A FIGHT
After Tinbergen, 1951.

In the mute swan, fighting may be interrupted by nest-building movements, viz., the picking-up of straws (Portielje, 1936). As I said before, the vertical threat-posture of male three-spined sticklebacks (Fig. 4) which I interpreted as displacement eating in my first paper (1940), could later be proven to be incomplete sand digging, the first stage of nest building (Tinbergen and Van Iersel, 1947).

Sexual movements

Even sexual movements may occur in situations that presumably do not affect the sexual drive itself. Palmgren (1934) describes how caged willow

warblers, when showing the inhibited migratory movements called "migratory restlessness," intersperse them with courtship behavior. When cormorants are fighting in defence of the nest (the center of their territory) they show, alternating with aggressive behavior, various sexual activities, such as wing-flapping and "gargling," both movements used in precoition behavior.

In several birds coition has been observed to occur in situations where there is reason to believe that the sexual drive cannot be responsible. Makkink (1936, p. 14) reports of the avocet "that copulations often occurred after the birds had been flushed. Further it was striking that they also often took place as a continuation of a battle. So too after an excitement." It would be worth while to know what kind of excitement was involved, for this is of course decisive for proving the displacement character of the copulations; however, the two situations specified suggest that fighting, flight, or both, were involved rather than the sexual drive. Armstrong (1950) cites other similar observations.

FIG. 4. DISPLACEMENT SAND-DIGGING IN THE THREE-SPINED STICKLEBACK
After Tinbergen and Van Iersel, 1947.

Lastly, song is often uttered in circumstances which have nothing to do with reproduction. For instance, a skylark may burst into violent song after just having escaped from a duck hawk or a hobby, and numerous other instances of displacement song are known.

Food-begging movements

In the herring gull the introduction to coition consists of mutual "head-tossing" (Fig. 5). Both birds withdraw their heads, and rhythmically point the bill upwards with a short jerky movement. This behavior is identical with that by which full-grown young beg their parents for food. Sometimes the head-tossing is done by the female alone; in that case it usually leads to the male's feeding her. Accurate descriptions are found in Goethe (1937) and in Tinbergen (1952).

Incubation

According to Kortlandt (1940b), cormorants often interrupt nest-battles by bouts of "false brooding." It is much less common, however, than sexual displacement activities are in the same situation.

The false brooding of various waders, notably the oystercatcher, as a reaction to a predator near the nest, may be interpreted as displacement brooding. This however depends on the underlying drives. Makkink (1942) thinks we have to do with an autochthonous continuation of brooding itself, which was interrupted when the bird had to run from the nest. I suggest as another possibility that a combination of the attack- and the escape-drives is responsible, but I cannot prove this.

FIG. 5. PRECOITION DISPLAY ("HEAD-TOSSING") IN THE HERRING GULL
After Tinbergen, 1940.

Makkink reports (1936) that during exciting hostile encounters avocets may suddenly sit down. He does not interpret this movement, but Kortlandt argues that it must be displacement brooding. Although in this false brooding several characteristic elements, such as ruffling the ventral feathers, scraping with the legs, and the waggling movements ordinarily shown by birds settling on the eggs, are absent, this in itself is not against the interpretation, since displacement activities often remain incomplete. Koehler, in a foot-note in my 1940-paper, describes this incomplete brooding on the part of a ringed plover which was disturbed at the nest.

Sleep

Even sleep may appear as a displacement activity. This was first discovered by Makkink

(1936) in the avocet (Fig. 6). It has since been observed in various other waders, always in aggressive situations (oystercatcher (Fig. 7), Makkink, 1942; Edwards, Hosking, and Stuart Smith, 1948; turnstone, Bergman, 1946; common sandpiper, Poulsen, 1950). I saw it a few times in fighting snow bunting males (Tinbergen, 1939a).

Analysis

The underlying drives

The above review leads to a hypothesis about the causes of displacement activities.

At first glance, a certain deliberation on the animal's part might seem to play a role, and this naturally tempts one to give an anthropomorphic, psychological explanation. For instance, when an aggressive stickleback or an aggressive gull makes incipient nest-building movements, one might suppose that they are trying to show

FIG. 6. DISPLACEMENT SLEEP IN THE EUROPEAN AVOCET DURING A FIGHT
After Makkink, 1936.

to the other of their species that this is the spot where they intend to build a nest. I consider this anthropomorphic interpretation unsatisfactory, not only because by its very nature it can neither be proved nor disproved, but also because it can only be applied to these special cases and leaves all the other cases unexplained. If herring gulls and sticklebacks show nest-building movements in order to advertise their nest-building intentions, then why does a starling in the same situation preen its feathers, a skylark peck at the ground, or an avocet go to sleep? Certainly not in order to show that this is where they want to preen, to eat, to sleep?

Another type of explanation is offered by Makkink (1936, p. 27). He supposes that a fighting bird is sometimes overcome by disgust. "When this disgust is not strong enough to make the bird attack, fly off or go away, it brings about another manner to withdraw from the surrounding birds." Again, apart from the problem whether this psychological interpretation satisfies us as an ethological explanation as well, it is difficult to conceive that this withdrawal from an unpleasant situation could be effected by eating, nest-building, and preening just as well as by sleep.

Thus it seems justifiable to try and find another explanation. I believe I can give a plausible, if somewhat tentative explanation. In the main, this is the theory I put forward in 1940; on the basis of new facts, I have changed my views on some minor aspects, and also extended the theory somewhat.

First, it is clear that all the instances mentioned concern innate behavior patterns of a type that is usually dependent, at least in part, on internal impulses. When performed in non-irrelevant situations, these activities use up at least part of the specific action potential; or, in other words, they give some relief to the underlying drive, they lower

FIG. 7. DISPLACEMENT SLEEP IN THE OYSTERCATCHER
Modified after Edwards, Hosking, and Stuart Smith, 1948.

the motivation. This is inferred mainly from the fact that shortly after performing an activity the animal is, for some time, less ready to show the same activity again, even under exactly the same conditions as before. Are there indications that displacement activities do the same, that they are also an outlet of strong impulses?

There are, mainly, two types of situations in which displacement activities occur: a hostile situation, and a purely sexual situation. Further, irrelevant acts may occur in birds that are incubating or leading the young when they are disturbed by predators. I will consider these situations separately.

The hostile situation. One circumstance which I have not emphasized thus far seems to give the key to the solution of the problem: displacement activities are most frequent during boundary disputes. In order to make clear what bearing this has on our problem, it must be recalled that, in a

territory-owning male, a strange male may release two entirely different reactions, depending on where he meets the stranger. An intruder into the territory releases attack, but the very same individual met outside the territory is ignored or even, if on its own ground, avoided—i.e., it releases escape. Usually, there is no sharp boundary, but aggressiveness decreases and the avoidance tendency increases with increasing distance from the territory's center. When two males meet each other somewhere between the two territories, each is influenced by the other in two ways. First, because the other is so near the territory, the owner is roused to attack. But the stranger releases avoidance as well, for it is not exactly in the owner's territory, but just outside it, and in its own territory. Each male is in the same ambivalent state, which often finds expression in an ambivalent reaction: attack and retreat alternate quickly

FIG. 8. THE UPRIGHT THREAT POSTURE OF THE HERRING GULL

and repeatedly. This reciprocal "pendulum"-movement can often be observed in sticklebacks; I saw it also in male snow buntings; one "pendulum duel" lasted for nearly an hour without pause. Pickwell (1931) described the same of the prairie horned lark.

These observations show that two drives, attack and escape, are activated at the same time. Neither can find an outlet in complete behavior, for they are incompatible, but the alternation of mere intention movements seems to be a sufficient outlet so long as the drives are not too strong. Incidentally, their occurrence facilitates the recognition of the nature of the drives. Essentially the same situation, only in a more intense form, leads to displacement activities. Our hypothesis therefore is that the displacement activities are outlets through which the thwarted drives can express themselves in motion.

In birds, experimental proof of this hypothesis is difficult to obtain. Three-spined sticklebacks, however, offered a good opportunity for experimentation. It is possible to release the hostile responses in territorial sticklebacks by offering a crude model, an elongated object of about stickleback size, with a blue eye and a red underside. When this is lowered into an occupied stickleback territory, the owner attacks it. Now if the model, instead of fleeing—as any real stickleback would do—fights back, that is to say, if the experimenter hits the owner with the model as hard as he can, the territory-holding male will, after a short period of intensified attack, ultimately flee. It turns dark on the back, and slips into cover, where it remains motionless, keeping an eye on the terrifying stranger. This of course is a rather unnatural situation, for in nature intruding males will rarely fight and beat an already settled opponent. (Occasionally however, this happens, at least in birds, as every bird watcher knows.) If now the model is quietly held in the territory, the owner's mood will gradually change. The attack-releasing stimuli are being sent out by the model as before. In the meantime, the after-effect of the flight-inducing beating wanes. That this is so can be seen by the fact that, after some minutes, the owner begins to attack again. Now just before the actual attack comes, the male adopts the vertical threat posture, which, as we saw, is displacement sand-digging. This means, that a displacement activity indeed appears when the fighting drive and the escape drive are in equilibrium.

This experiment therefore confirms the hypothesis based on an analysis of the situation and of the intention movements shown in a low-intensity combat.

Although experimental evidence has not yet been produced in birds, the circumstantial evidence we have suggests that the same explanation holds here too. I have already mentioned the ambivalent "pendulum flights" in the prairie horned lark and in the snow bunting. I have more detailed data on the herring gull. Although colony birds, herring gull males defend territories as fiercely as any other territorial species. In case of intrusion, a territory-holding male chases the stranger. When on strange territory itself, it flees directly the owner attacks. Boundary clashes between neighboring males, however, release quite different types of behavior. A male walking towards an intruder assumes the "upright threat posture" (Fig. 8). The neck is stretched upward and forward. The head is pointing down. Some-

times the wings are lifted. This can all be recognized as incipient attack. In a real fight, a herring gull attempts to get on top of its opponent and peck down at it; also it delivers powerful blows with the wing. The stretching of the neck, the position of the bill, and the raising of the wings are the very beginnings of these fight movements. The upright threat-posture therefore shows that the gull is in fighting mood.

While the bird approaches its opponent—who, on its territory itself, usually adopts the same attitude—a slight but definite change in its posture is evident. The neck, which was stretched obliquely forward at first, is withdrawn in a more vertical posture. When the two birds are very close together, one of them may even bend the neck still further back, through the vertical. The bill is then no longer pointing down but is about horizontal. Such a bird is the more liable of the two to withdraw. This withdrawal of the neck is, I think, incipient retreat, or defence rather than attack. A bird which gets the worst in a struggle withdraws, if facing its enemy at all, in the same position. The upright threat-posture therefore seems to be an intention movement of attack, mixed with the intention movement of defence. This points to the conclusion again that two antagonistic drives are active, of which only the intention movements can appear simultaneously. The close parallel with the "pendulum duels" of sticklebacks, snow buntings and horned larks is clear. The only difference is that the herring gull combines the elements simultaneously into one movement instead of showing the two elements in quick alternation.

A bout of mutual threatening between two herring gulls may either die down (as it does only too frequently, much to the observer's annoyance), or it may develop into a genuine fight. If it does, the behavior passes into one of two types of more intense threat. One type is "grass pulling." The gull pecks at the ground, takes some nest material in the bill, and tears it out. Sometimes it will keep it in the bill for some time, but usually it drops it at once, sometimes with the well-known sideways movement of the head. In spite of some peculiarities which distinguish this movement from the real movements of collecting nest-material—differences to which I will presently return—there is, I think, no doubt that this threat display is derived from nest-building movements. Since both the environmental situation ("boundary clash") and the movements exhibited by the birds show that they are being urged, not by a nest-building drive but by a combination of aggressiveness and of a tendency to flee or to withdraw, this grass pulling is clearly a displacement activity.

The next type of threat behavior in the herring gull is a rather puzzling one. It is shown in about the same circumstances as grass pulling but it takes place when the partners of a pair defend the territory together. They bend their legs, squatting down in a half-hearted way, and, lowering the tongue bone, which gives them a very curious facial expression, make rhythmic pecking movements at the ground, without actually touching it, however (Fig. 9). A low, rhythmical sound is produced simultaneously. Noble and Wurm (1943), who described the same movement in the American laughing gull, called it "choking."

Choking is not only shown in an aggressive situation, but also when there is no sign of aggressiveness. When a pair is selecting a nest site in the territory, or when they are actually building, or when, in the beginning of the incubation period, they meet at the nest, exactly the same ceremony occurs. One bird may actually sit in the nest while the other squats somewhere at its side. The accompanying movements in the non-aggressive situation belong to the nest-building system: for instance, leg-scraping is often shown. Leg-scraping can also, though rarely, be observed during the aggressive choking. Since choking in non-aggressive situations is always connected with nest-building, I consider it part of the nest-building pattern, although its exact function in that context is obscure. I rather think that even in the nest-building pattern choking is a derived and probably complex movement, but that is irrelevant here; for our present purpose it is sufficient to state that aggressive choking is a displacement activity "borrowed" from the nest-building pattern; where it came from is a subsequent problem.

FIG. 9. "CHOKING" OF THE HERRING GULL
After Tinbergen, 1940.

There is, however, some disagreement about the interpretation of non-aggressive choking. Portielje (1928), who observed it in the herring gull, and Kirkman (1937), who found it in the black-headed gull, both hold that it is part of the parental pattern and is derived from feeding the young. As I have argued in more detail in my forthcoming book on the herring gull, I cannot agree with them. In both species, the feeding behavior is quite different from choking. Also, evidence of related species, such as the common gull, the Iceland gull, and the laughing gull (Noble and Wurm, 1943) lead me to believe that here too choking has to do with nest-building rather than with feeding the young.

My conclusion therefore is that aggressive choking is a displacement activity derived from nest-building. What function choking has in the nest-building pattern is not quite clear, because it does not materially add to the building of the nest. As I said, it may be a derived movement itself. In that case the aggressive choking would be the displacement of an already secondary movement. A similar situation is reported by Kortlandt of the cormorant.

The hostile behavior of the herring gull therefore contains at least five different types of movement. In extreme cases we may see either escape, or forthright attack. In case of simultaneous and balanced activation of the drive to attack and the drive to escape we see either a combination of the intention movements of the two drives, or, in case of a higher degree of activation, one or another type of displacement nest-building.

The displacement activities in the aggressive behavior of the herring gulls therefore can be explained in the same way as displacement sand-digging in the three-spined stickleback; in both cases we have strong evidence of a conflict between two drives, the executive patterns of which are antagonistic and incompatible. The result is that the drives activated by the situation (environmental and internal) cannot find an outlet in autochthonous consummatory acts and have to find an outlet through other, "irrelevant" patterns.

I have little doubt that the occurrence of displacement activities in hostile situations in other species is to be explained in a similar, though not necessarily identical, way. In all cases there is reason to suppose that there is a surplus of drive, due to the simultaneous activation of incompatible instincts. Recently, Hinde (1952) has analyzed the hostile behavior of Great Tits and arrived at similar conclusions.

Sudden cessation of external stimulation. Kortlandt (1940 a, b) has observed that aggressive behavior in the cormorant may suddenly change into displacement behavior, derived from the sexual patterns. This happens especially when the opponent flees suddenly. His explanation is that the fighting drive has been so intensely aroused that a sudden escape of the opponent leaves the animal with an activated fighting drive but minus the external object at which the fighting can be aimed. In other words, the actual fighting, the consummatory activity which alone can use up the fighting impulses, cannot be performed because necessary external stimuli are absent, and this leaves the animal with a residuum of fighting drive. The displacement activities serve as an outlet of this residuum of drive.

I think this explanation has to be applied to a number of cases. When a drive is strongly activated, it cannot die down immediately, but there is a period of "after discharge." During this period there is a tendency to movement, strong at first, and weakening gradually. If the movements belonging to this drive are relatively independent of external releasing stimuli, that is, if they can easily go off "in vacuo," we may see some autochthonous activity. But if, as is the case in many behavior patterns, external stimuli are essential for the release of consummatory activity, the disappearance or, in general, the absence of the stimulating object means a thwarting of the drive. It cannot find an outlet through autochthonous activity, and displacement activities result. This happens not only with the fighting drive, in situations as described above, but also with other drives. When an incubating bird is relieved at the nest by its partner, its brooding drive, although relatively low after a spell of incubating, is still high enough to give rise to displacement activities when the approach of the partner stimulates it to leave the nest, and thus suddenly takes away the nest and eggs, which provide the stimuli necessary for actual brooding. In Laro-Limicolae the displacement activity most commonly seen under such circumstances is the well-known picking-up of straws, shells, and other material and the sideways movements of the head by which they are thrown away. The fact that this is done not only by the relieved bird but also by the relieving bird

before settling on the eggs, requires another explanation. I believe that the relieving bird, returning under the influence of its increased incubation drive, becomes progressively more strongly stimulated as it approaches the nest. Until it can satisfy this drive by actually sitting on the eggs it vents it through displacement activities.

There are indications that the situation is really somewhat more complicated (for instance, the to-be-relieved bird often begins to show displacement behavior before the partner has taken possession of the eggs), but in the main I think we have to do with an excess of brooding drive, and not with any conflict.

In a similar way we must, I think, explain post-coitional behavior. After coition, the drive dies down gradually and not abruptly, and this period of "after discharge" gives rise to displacement activities. The post-coition behavior is often difficult to judge, because it consists so often of preening or bathing movements, which both could be considered autochthonous responses to the disordered state of the plumage. But in the red-necked phalarope, where the female takes the initiative in courtship and coition, she often attacks the male immediately after coition. Also, she goes on land and indulges in a bout of nest-building (Tinbergen, 1935).

Here again we have to do with an excess of one drive only, and not with a conflict between drives. This excess exists temporarily when a drive is activated but the stimuli necessary for the release of its consummatory acts are absent.

Pre-coition display. As we have seen in the descriptive section, the courtship displays and pre-coition displays of many species contain displacement activities. We have to examine the question whether in these cases there is also evidence of a surplus of drive, and if so, whether this surplus is due to a conflict between two drives, or to an excess of one drive only, or to something else.

I think there can be no doubt that the pre-coition display is indicative of a state of intense activation of the sexual drive. Further, the display ends abruptly as soon as the animal performs the consummatory act of the sexual drive. The male avocet, for instance, preens until it mounts the female; the male herring gull goes on tossing its head until it attempts copulation. The display appears only as long as the sexual drive does not express itself in coition. Again, therefore, we have to do with an activated drive which gives rise to displacement activities as long as no autochthonous outlet is used. This conclusion remains rather tentative, however, unless we can find out why the drive does not give rise to autochthonous activity.

In my 1940 paper I discussed two possibilities. (1) In many cases the actual mounting of the male has to be released by a special attitude of the female, indicating her readiness to mate. Thus in the avocet, the male's pre-coition preening goes on until the female adopts the flat, horizontal coition-attitude. In this, and similar, cases the male seems to be dependent on a stimulus from the female to such a degree, that without this stimulus he is unable to copulate. Strong activation of the sexual drive and absence of the necessary external stimulus seem in such cases to be the causes of an excess, and the displacement activities during pre-coition behavior can be considered to be due to this excess of sexual drive.

Together with J. Van Iersel, I have analyzed the pre-coition behavior of the male three-spined stickleback, which is a chain of five activities. Two of these are displacement activities, and they appear in situations when the sexual drive is strongly activated but the next reaction of the female (which in both cases has been proved to be indispensable for the continuation of the male's behavior) is not yet forthcoming. The evidence in this case therefore supports the view that the excess is due to the activation of one drive.

(2) Various authors (Verwey, 1930; Kortlandt, 1940b; and others) have argued that copulation in birds brings about a situation which they normally avoid, viz., bodily contact with another individual. It is quite possible therefore that the pre-coition situation evokes in each individual a tendency to keep away from the partner as well as a tendency to draw together. In that case, the cause of the excess of the sexual drive would again be conflict.

Although since 1940 our knowledge of displacement behavior has increased, it is still not possible to decide which of the two hypotheses is the correct one. I am rather inclined to think that they are both true, that in many cases the main cause of the excess is lack of required external stimulation by the partner, but that conflict may be partially responsible as well. I even think that the tendency to withdraw may not be the only nor the main drive in conflict with the sexual drive, but that there may be a tendency to attack the female as well. Without entering into a detailed discussion

of the evidence pointing to this, I may recall the fact that so many male birds (and other animals) show, as the first reaction to an intruding individual, the same response to females as they do to males, and that this first reaction is often a hostile one. It is the function of the behavior of the female following such an encounter to suppress the male's aggressiveness and to elicit its sexual responses.

The herring gull's pre-coition behavior gives some support to the view that something more than simple lack of stimuli is involved. As described above, both male and female toss their heads before coition, and this head tossing must be considered to be displacement-begging. The female, unlike other species, has no special posture indicating readiness, but continues to toss her head even after the male has mounted, only discontinuing it during actual contact of the cloacas. The male therefore mounts without having been stimulated to do so by a particular gesture. This means that his head-tossing cannot be due to the absence of coition-releasing stimuli, and that there must be another cause of the thwarting of the sexual drive. Whether this has to do with a conflict with the fighting drive seems uncertain.

Concluding, it seems probable that in pre-coition behavior again the occurrence of displacement activities is due to an excess of drive. The excess may be due to conflict, as in a hostile situation, but this is not necessarily so; in fact, the main cause of the surplus is the arousing of the sexual instinct while indispensable external stimuli are absent. Since misunderstandings have arisen in this respect, it is necessary to emphasize that excess of drive is not always due to conflict.

Special mention must now be made of displacement activities during those phases of courtship not immediately leading to coition. Heinroth has already said that "courtship ("Balz") and coition ("Begattung") often have nothing to do with each other." This is true in so far that not all courtship leads immediately to coition; much courtship leads to pair formation, and coition is often preceded by a type of behavior quite different from this early courtship. This depends on whether there is a period of "betrothal" or not, and this differs from species to species. The male mallard provides an instance of this duality of courtship and pre-coition behavior. The latter consists of the vertical down-and-up movements of the head, which is, according to Lorenz (1941) originally an intention movement of mounting. Courtship, which is intensive in autumn and winter, is quite different. One component of it is displacement preening.

The question arises whether during this type of courtship there is a similar excess of drive, as in pre-coition behavior, and, if so, what is the nature of the activated drive, and why there should be an excess. Although I believe that we again have to do with an unsatisfied sexual drive, I cannot present conclusive support for it, and the need of further careful study must be emphasized.

The situation "predator near brood." Displacement activities have been recorded in numerous cases where birds were flushed from the nest or the young by man or other predators. In some birds the nature of the behavior shown in this situation is very obvious, as in the lapwing, which shows incomplete, sometimes even complete, feeding movements. In many birds the displacement behavior seems to be ritualized as an adaptation to a diversionary function, and may be difficult to recognize. Yet both Armstrong (1949) and Williamson (1950) show that many diversionary patterns contain displacement activities.

There is still uncertainty about the nature of the drives involved in this situation. It seems to me plausible that we have to do with a conflict of at least two drives. Since the bird actually keeps away from the predator, the fleeing drive is no doubt involved, which is entirely consistent with behavior outside the breeding season. I think further that we need not doubt that a drive to attack the predator is also activated. So many birds actually attack predators at the nest that when they fail to attack, one cannot help believing that this is merely because the drive to attack is just too low to overcome the fleeing drive. This is supported by the fact that the more formidable predators are less liable to be attacked than smaller predators.

It seems probable therefore that there is a conflict between these two incompatible tendencies, the tendency to keep away from the predator and the tendency to attack it, a part of the system of reproductive drives. However, we know that a third drive is always active in this situation, the parental drive, or rather that part of it leading to incubate or guard the brood. The part played by this drive is uncertain.

Obviously, the problem is complicated, and although much has already been written on it,

the basic question of the nature of the underlying drives is still unsolved.

Sleep as an outlet. If my thesis is correct, and displacement activities are an outlet of an excess of drive, it is at first glance incomprehensible that sleep should appear as a displacement activity, for sleep is commonly regarded as lack of activity rather than activity. Not so long ago no physiologist believed that sleep was due to nervous activity; on the contrary, sleep was proved to coincide with suppression of certain aspects of nervous activity, such as sensitivity to external stimuli. On the other hand, several psychologists have regarded sleep as an instinctive activity (e.g., McDougall). The recent development of this problem is highly interesting; it has shown the psychologists to be right, and instead of a puzzle sleep has become an impressive test-case of our theory of displacement activities.

From the point of view of ethology, sleep is similar to consummatory acts in that it is preceded by a special type of appetitive behavior. Many animals resort to a special sleeping place or roost, many birds even carry out extensive migrations every evening. The orang utan builds a sleeping platform every day (Portielje, 1939).

Now it is of considerable interest that Hess (1944) has proved, by his well-known method of direct electrical stimulation of the brain of the cat, that sleep can be provoked instantaneously if a certain area of the hypothalamus is stimulated. Depending on the exact locus of stimulation Hess could produce sleep, aggressive behavior, eating, or defecation. This shows first that sleep, with the accompanying suppression of nervous activity, depends on activity of a strictly localized part of the brain, and further that in this respect it behaves exactly like movements generally recognized to be dependent on nervous activity. These facts show that there is no inconsistency in the occurrence of sleep as a displacement activity. They demonstrate also how a study of displacement activities may help towards a better understanding of instinct in general.

The types of movement used as outlets

Innate or learnt? So far as we know at present, displacement activities are always innate motor patterns, at least in fish, birds, and most mammals. Man forms an exception, for he may use acquired patterns such as lighting a cigarette, or fumbling a bunch of keys, etc. This does not mean that man does not use innate patterns at all. The frequency of all types of scratching, rubbing the chin, etc., in men, and of adjusting the hair in women, shows that there is a strong tendency to find an outlet through movements originally serving care of the body surface, the "comfort" movements. Several of these movements are, I think, innate. Another innate pattern used is yawning, and even sleep. The use of acquired patterns, however, occurs widely in man, and thus far no parallel has been found in animals, although it must be admitted that the other primates have not been adequately studied from this point of view. I happen to have observed that chimpanzees under certain conditions of frustration of feeding are subject to violent outbursts of scratching.

In most animals studied there is a certain regularity in the occurrence of displacement activities. A hostile situation releases displacement digging (nest-building) in a male stickleback, but displacement preening in a starling, and displacement sleep in an oystercatcher. A thwarted sexual drive will never release displacement digging in a male stickleback, but instead leads to displacement fanning (a parental activity, serving ventilation of the eggs if autochthonously employed). This shows that the thwarted drive is somehow limited in its outlet. The outlet differs from one drive to another, and from one species to another. As we will presently see, this connection between thwarted drive and type of outlet is not always entirely rigid. First, in mammals the outlet is not found through one particular consummatory act but through a higher system, through a variable pattern of related activities. This was pointed out by Schenkel in his admirable study of the social behavior of wolves (1947). To some extent this is also true of birds and fish. A stickleback may occasionally pick up nest material in hostile situations of high intensity. Nevertheless, this is rare; and it should also be noted that sand-digging and picking up nest-material both belong to the nest-building pattern. I will return to this problem later. Second, some species show a variety of displacement activities even in one situation. Thus the avocet picks up nest material, or shakes the head, or makes feeding movements in intermissions of fights; movements, therefore, that belong to three different instincts (Makkink, 1936).

All these cases show that in some species a particular situation may provoke more than one

type of displacement activity, but even in part of these cases the various displacement activities belong to the same major pattern. We may state therefore that there is often a definite connection between the thwarted drives and the type of displacement activity used as an outlet. This connection differs from one species to another. I cannot explain these differences; yet I think there are some facts which suggest in what directions we may have to look for an answer.

Outlet through activated instincts? It is striking that displacement activities are often innate movements which are frequently used in everyday life: eating, preening, etc. Further, when man uses an acquired motor pattern as an outlet, it is always a pattern which he is using quite frequently for its own sake. This seems to indicate that an animal is apt to use as outlets those patterns which for some reason offer least resistance. As we shall see further on, the intensity of the thwarted drive which causes the displacement activity always differs from the intensity of the displacement activity itself. Even when an animal is strongly motivated, the displacement activity which occurs when the drive is thwarted is incomplete and of low intensity. This indicates that displacement meets with some kind of inner resistance, causing "loss of impulses." This leads us to expect that either external factors or the state of activation of an instinct could influence the likelihood of its patterns being used as outlets by another instinct.

The only reliable evidence on the first problem is brought forward by Kortlandt (1940) for the cormorant, and it seems to speak against such an influence. Fighting cormorants show displacement wing-flapping and "gargling" (both derived from the sexual pattern) and "nest-quivering" (derived from the nest-building pattern). Now although these activities, when autochthonously aroused, show a marked seasonal fluctuation, being frequent in spring but almost absent in winter, their use as an outlet during fighting remains the same throughout the year. This can be understood on the basis of recent research on the influence of hormones on behavior. In domestic fowl (and in other birds) incubation and care of the young are dependent on the presence of prolactin, a pituitary hormone. Domestic cocks, which normally neither incubate nor take charge of the chicks, will respond to chicks and show all the maternal behavior when injected with prolactin. However, they do not show any interest in eggs. This and similar observations suggest that apart from the hormone there must be a definite mechanism in the nervous system reacting to the hormone stimulation. The mechanism of maternal care is obviously present in the cock, although owing to absence of prolactin it is never used; but the mechanism of incubation is absent, because even prolactin stimulation (which promptly activates maternal behavior in non-broody hens) fails to bring about maternal behavior in the cock (Nalbandov and Card, 1945).

This suggests that in the cormorant the seasonal fluctuation of the autochthonous reproductive drive is due to hormone fluctuation, but the nervous mechanisms are present and ready for action during the whole year. At least in this case the state of activation of the sexual instinct —the extent of which depends on the concentration of sex hormone—does not determine the liability of sexual movements to be used as outlets of other instincts. It is, I think, important to see the restricted nature of this conclusion: it remains undecided whether activation by factors other than hormones may influence this liability.

"Pure reactions" are not used. Another fact reported by Kortlandt indicates that the degree of spontaneity of an activity may determine its liability to be used as an outlet. Kortlandt draws attention to the fact that of the four patterns of the comfort instinct: bathing, preening, shaking, and wing-drying, the three first-named are often performed spontaneously, whereas wing-drying is an (almost) pure reaction. It is perhaps significant that the first three patterns are used as displacement activities, but wing drying is not. It seems probable that the liability of a movement to be used as a displacement activity depends on the extent to which this movement, in its autochthonous form, is dependent on internal factors. This could be tested by correlating the degree of spontaneity of activities with their use as outlets. The degree of spontaneity could be assessed by various criteria, particularly the frequency of vacuum activities, and the exhaustibility. If such a correlation exists, it could explain why some activities are used more often than others. It could not explain, however, why the sexual and the fighting instinct use different outlets when thwarted.

The influence of the initial posture. Another possible factor has been suggested to me by Prof. G. P.

Baerends. A study of the threat behavior of various fishes leads to the following, admittedly highly tentative, supposition. Many fish tend to bend forward and downward in a balanced hostile situation. In the three-spined stickleback this is the introduction to sand digging. The ten-spined stickleback and, to a lesser extent, the sea stickleback do the same; yet they build their nests in plants well above the bottom and do not dig a pit for the nest at all. This forward bending is also found in other fish, such as various cichlids. It is possibly a posture which facilitates stopping or even withdrawing.

Now the occurrence of forward bending in the ten-spined stickleback could either be a remnant of displacement digging, originated at a time when all sticklebacks built nests at the bottom, or, the other way round, the forward bending could be primary and have developed into displacement digging in the only species which has the digging pattern. In view of the occurrence of forward bending in non-digging fish, the second supposition does not seem improbable. It would then be possible that the three-spined stickleback "chose" displacement digging as an outlet because forward bending is also the natural preparation of sand digging. In other words, the posture in which the animal finds itself when a drive is thwarted might decide which activity will be used as an outlet. This hypothesis could be used as an explanation of several other displacement phenomena. The male three-spined stickleback, when strongly stimulated sexually by a female, but unable to mate because the female does not follow it to the nest and thus fails to provide the only stimulus capable of releasing sperm ejaculation, swims towards the nest, which is the normal introduction to the sexual act. It does not enter it as long as the female does not enter and lay eggs, but it stops in front of the nest and remains there in a forward-bent attitude. If the female still does not react, the male's thwarted sexual drive finds an outlet through fanning and through "pushing" (a nest-building activity). It is striking that exactly these two movements require the same introductory position of standing in a down-bent attitude above the nest.

A similar explanation could be applied to the grass pulling of the herring gull. This develops from the upright threat-posture which, as we have seen, is an autochthonous movement, combining elements of preparation to attack and of withdrawal. The bill is pointed downward, ready to peck at the opponent. Instead, however, it pecks at nest material on the ground. Again, both autochthonous and allochthonous movements have the same preparatory posture.

The curious displacement-begging of the female herring gull before coition and before conjugal feeding could perhaps be similarly explained. As in so many birds, the male's main reaction when in reproductive mood is aggressiveness. Mating can only take place if the female manages to suppress the male's aggressiveness. She does this by adopting an attitude the opposite of the upright threat-posture: instead of standing upright, she bends forward; instead of stretching the neck, she withdraws it as far as possible; instead of pointing the bill down, she points it forward. This is the same posture adopted by the young when they have grown up so far that their gull-like shape (as distinct from the chick-shape) is apt to release aggressiveness instead of parental care in the parents. This posture, favored by selection as the best means to appease the male, is in the pre-coition situation continued into head-tossing, which is the infantile begging movement.

Although these few cases do not yet prove much, and although the principle, if true, would not suffice to explain all types of displacement activities, it seems to be worth testing. As with other problems, we need more facts, derived not from casual, isolated observations, but from long and detailed studies.

The influence of external stimuli. The external situation at the moment when displacement activities occur may influence the type of displacement activity shown. A number of observations prove that in certain situations a variety of different displacement activities may occur. Which of these will occur seems often to depend on the external situation; thus the presence of food may facilitate displacement feeding, nest material may tip the balance in favor of displacement-nest-building, etc.

Fighting cormorants usually vent their excess of drive through wing flapping, gargling, and "nest quivering." If nest material or an appropriate substitute is absent, however, no nest building is observed, and the drive finds an outlet through wing flapping and gargling only (Kortlandt, 1940). Armstrong (1950, p. 369) writes: "When Eider Ducks, *Somateria mollissima*, are disturbed from the nest they perform various

displacements, but do not normally displacement-drink, but in Iceland a bird which I alarmed found a stream in her way and displacement-drank repeatedly." It is possible that some of the other observations reported by Armstrong must be interpreted in the same way.

In other cases, however, no such variability and no dependence on the external situation is found. Threatening male sticklebacks show always displacement sand-digging, irrespective of whether there is sand to be carried or not, threatening gulls may even "choke" while swimming (Portielje), and so on. It seems that variability and dependence on external stimuli are most evident in such displacement activities as have no signal-function (see below). The acquisition of a signal (releaser-) function, which is undoubtedly a secondary development and which leads to loss of the allochthonous character of the displacement activity, seems also to lead to a more rigid fixation of certain displacement activities to particular drives. This would mean that the situation of variable outlets is the more original state. It would follow that an insight into the problem of why one displacement activity would be more probable than another could be promoted best by concentrating on the nonritualized displacement activities, those without releaser function.

Reciprocity not proved. Armstrong (1950), following Kortlandt, has claimed that there are indications of a tendency of reciprocal linkages between drives in such a way that if drive *a* when thwarted finds an outlet through patterns of drive *b*, then drive *b*, when obstructed in its turn, tends to find its outlets through patterns of drive *a*. "Thus epigamic displays tend to "spark over" or become side-tracked into fighting, and vice versa." (Armstrong, 1950, p. 368). I cannot support this from my own experience. In the three-spined stickleback, while fighting "sparks over" to sand digging, this never happens the other way round. While the sexual drive finds an outlet through fanning, the parental drive, or fanning itself, if obstructed, does not lead to sexual displacement-activities. Although fighting in the herring gull "sparks over" to nest-building, the reverse is not true. Of course, in species such as the avocet and the cormorant, where a thwarted drive may find an outlet through more than one other pattern, the chances are (there being so few patterns) that the reverse may occasionally happen. My experience thus far does not show reciprocity to be more common than chance in this sense would make it.

Displacement as regression? Nor is there any foundation for the belief that "displacements are often regressions" to behavior belonging to an earlier phase of the cycle, as Armstrong claims. This of course would be well-founded only if in reproductive behavior displacement-activities were borrowed from earlier phases more often than from later phases. So far as we know, one happens as often as the other, and in addition the outlet may involve non-reproductive activities such as preening, sleep, etc. Thus fighting sticklebacks, fighting gulls, and courting sticklebacks all use displacement activities borrowed from later phases. Incubating gulls and waders, which show nest-building behavior when obstructed, do the reverse.

The observation from Palmer quoted by Armstrong, that "a Common Tern whose eggs have just been removed proceeds to make 'scrapes'," is open to more than one interpretation. If the nest was on sand, it might have been an autochthonous activity for the purpose of digging up eggs covered with sand. It is also possible, if the test was done early in the cycle, that the scraping was an autochthonous regression, the bird beginning a new cycle. Anyway, generalizations based on so narrow and uncertain a base should be critically tested with all the available evidence before publication.

Differences between the displacement activity and its "example"

In the preceding sections I have occasionally remarked upon the fact that a displacement activity usually differs from the autochthonous act from which it is derived, its "example." For instance, the displacement digging of a stickleback is often so unlike real sand-digging that we did not recognize it for years. Also, various authors have repeatedly commented upon the "nervousness" of an animal when making displacement movements, which of course means that the movements were somehow different from what the observer was used to. These differences between displacement activity and example are based on various principles, of which thus far we have discovered three.

The incompleteness of the displacement activity. Displacement activities are usually incomplete in two respects. First, the act is often begun in a normal way but breaks off halfway. A fighting cock

pecks at the ground but is never or rarely seen to pick anything up, let alone to swallow it. Displacement preening is often superficial and incomplete. Oystercatchers, avocets, turnstones, and other waders displacement-sleeping in front of an opponent often fail to close the eyes; and it is not at all unusual to see them make a mere half-hearted turning movement with the head, as if they are going to put the bill on the scapulars, but stop halfway, before they actually touch the plumage with the bill.

It is now evident that this incompleteness is a matter of intensity. This was demonstrated by Van Iersel and myself in the case of the three-spined stickleback's threat posture. We could intensify the fighting by crowding several males in a relatively small tank, so that the individual territories were small and consequently the intensity of the fighting was high. The threat behavior then developed into complete digging. It is possible to arrange a number of observed boundary-clashes according to intensity on the basis of various criteria, such as the frequency and intensity of real attacks, duration of fight, or distance from the center of the territory. Roughly speaking, the completeness of the displacement digging is then seen to increase with increasing intensity of the fighting drive. This increase in completeness of displacement digging can be compared with the increase of completeness of autochthonous digging during nest construction when, in the course of a short time, the digging develops from a mere bending down of the body, as in low-intensity threat, through a number of intermediate stages into complete digging. The striking fact is that both the completion of displacement digging and that of authochtonous digging pass through exactly the same sequence of intermediate stages.

The displacement pecking of a lapwing disturbed at the nest will occasionally become so intensive that the bird actually captures and swallows worms. As a matter of fact, a colleague of mine who wanted to film a foraging lapwing succeeded by application of this knowledge.

There is still another problem which I think has to do with this matter of intensities. For various reasons not discussed here, it is rather surprising that a drive of a relatively high order of complexity (such as the fighting drive) should, upon being thwarted, as a rule give rise only to sand-digging and not to all other types of nest-building as well. Only occasionally other nest-building activities, such as collection of nest material and even actual building, may be seen to occur during or after a boundary clash. This seems to happen only after particularly intense fights. Now when one follows the sequence of activities during the whole nest-building cycle, it will be seen that sand-digging is the first element of this pattern to appear. When the frequency is plotted against time, sand-digging will be seen to increase in frequency, reach a peak, and then decrease again. Coinciding with this decrease other nest-building activities, such as the gathering of material, will appear. Soon they take over entirely, and digging ceases. This can be interpreted as an outcome of the growing intensity of the nest-building drive as a whole. Of all the systems subordinate to this drive, that of sand-digging has the lowest threshold. Consequently it appears first when the nest-building drive becomes activated; and until the activation reaches the threshold of the next element (gathering of material), all the nest-building motivation is used for sand-digging. If this is true, it would explain why sand-digging is the most likely of all the nest-building activities to appear as a displacement activity, and also why, with a very high intensity of the fighting drive, other nest-building activities begin to appear as displacements.

The incompleteness of the great majority of observed displacement activities is the more astonishing since they usually appear in situations of great "tension," that is to say, of strong but thwarted motivation, where experience leads us to expect behavior of full intensity. And as a matter of fact, when autochthonous behavior breaks through in such situations, it is always of high intensity. All these facts point to the conclusion that displacement meets with a strong inner resistance, and that only a part of the impulses available for action in the underlying drive reaches the motor centers of the displacement activity.

This explanation can probably explain another aspect of displacement activities as well. Several authors have commented upon what has been called a certain lack of orientation, or imperfect correlation with the object (Armstrong, 1950). It must be emphasized that the correlation with the object is by no means always imperfect; displacement bathing, displacement eating, displacement nesting are, as we have seen, complete and in perfect correlation with the object if

only the intensity of the underlying drive(s) is high enough. Further, autochthonous activities show the same lack of correlation with the object when the drive is low. The only difference between the two cases is that the absolute level below which the activity loses connection with the object is so much lower in autochthonous behavior than in displacement behavior, but this is entirely in line with the phenomena discussed above.

Superposition of autochthonous elements. The incompleteness of displacement activities is not the only aspect in which they differ from their autochthonous examples. This is obvious in the grass-pulling of herring gulls. That this is displaced collecting of nest material is clear from the concentration on nest material as object and from the form of the movement: the material is often thrown away with the well-known sideways jerking of the head found in so many Laro-Limicolae. The grass-pulling is different, however, from the autochthonous picking-up of nest material. First, an aggressive gull pecks into the grass or moss much more vigorously than it does when gathering nest material. Secondly, it often selects heavy grass-tufts or even roots that offer resistance to pulling, and it then pulls for all it is worth. Both the vigorous pecking and the pulling are instantly recognized when an actual fight is witnessed; they are part of the fighting pattern. To anyone who has seen a real fight it is clear that a grass-pulling gull treats the grass as it would treat the opponent if it only dared, or, in ethological terminology, if its fighting drive were not suppressed by its fleeing drive. The grass-pulling therefore differs from its example by a superposition of elements of the fighting pattern. In other words, it is a mixture of autochthonous and allochthonous elements. This superstructure of elements of fighting probably facilitates recognition by other gulls of this total gesture as threat.

Superposition of autochthonous elements does not occur only in this particular behavior of the herring gull. There are more instances, and I believe it to be a widespread phenomenon. It should be distinguished from ritualization, a concept to be discussed later. Ritualization is the outcome of a secondary evolution. Superposition is probably there from the beginning.

Superposition of autochthonous elements is one more indication that the interpretation of displacement activities as the result of a surplus of drive is correct. In the case of the grass-pulling it also points to another conclusion. When a conflict of drives is at the bottom of a displacement activity, it seems to be impossible to decide which drive furnishes the impulses for the displacement behavior: the fighting drive, the escape drive, or both. Kortlandt argues that it must be the fighting drive, because the escape drive really attains its end, namely, staying away from the enemy. I was never impressed by this argument and still think that the escape drive would be better satisfied if the animal fled altogether. But the fact that grass-pulling shows elements of the fighting pattern and not of the fleeing pattern seems to support Kortlandt's view. On the other hand, what would elements of the fleeing drive look like? Maybe it will be possible to study this in the stickleback, where activation of the fleeing drive causes not only movements, but also a change in color. If a threatening male stickleback were darker on the back than an attacking male, this would point to activity of the fleeing drive. I have made no observations on this point. A threatening male often erects one or both ventral spines, and this is not an element of attack but of defence. This suggests that the escape drive, as well as the attack drive, contributes to the displacement activity.

As has already been indicated, ritualization is another principle responsible for differences between displacement activities and their examples. This will be discussed after the releaser function has been dealt with.

The biological significance of displacement activities

Since displacement activities are so widespread, it seems improbable that they are a mere by-product, an accidental lack of elegance of the behavior system. On the contrary, I think we can distinguish two functions of displacement activities, a primary and a secondary one.

Displacement activities as outlets. My attention was called to what I will call the primary function by Dr. Liddell of Cornell University in 1947. Following a discussion on displacement activities in birds and fish, Liddell demonstrated to me some instances in goats and sheep. In the Cornell University Experimental Farm, Liddell and his collaborators study "experimental neurosis" in various mammals. These are subjected to a treatment of weeks or months during which they are confined in a narrow pen several times a day, and

get a heavy electric shock following a signal. The animals learn that the signal announces the shock, and between signal and shock they are subject to a strong tendency to escape. Actual escape, however, is blocked. This treatment results in the long run in "experimental neurosis," but long before neurosis becomes apparent the animals react to the signal by various displacement activities, usually movements belonging to the feeding patterns.

This work seems to show that neurosis may be the result of long-continued thwarting of the escape drive. The fact that displacement activities appear before a neurotic stage is reached, or rather that neurosis follows a long period of thwarting of a drive and consequent displacement activity, indicates that outlet through displacement behavior is a form of defence against neurotic disorder of the central nervous system, enabling it to "get rid" of the surplus of impulses which would otherwise damage it. The fact that Liddell's animals could not entirely escape neurosis does not contradict this hypothesis; after all, an animal cannot be expected to be adapted to the continued impossibility of escaping from a heavy bombardment of electric shocks over months at a time. For these reasons I think it is probable that displacements do serve a function as outlets, through a safety valve, of dangerous surplus impulses.

Displacement activities as social releasers. In many cases, displacement activities are reacted to by other individuals belonging to the same species. We have experimental proof, for instance, of the intimidating influence of displacement digging in the three-spined stickleback. This is of course why it is justifiable to call it threat behavior. It can scarcely be doubted that grass-pulling in herring gulls has also threat value. And although experimental proof has been provided in few, if any, cases, I do not think we need doubt that many displacement activities, particularly such as form part of threat or of courtship and precoition behavior, act as social releasers (for a review see Tinbergen, 1948).

The evolution of displacement activities

Ritualization. When displacement activities which have this releaser significance are compared with those that have no influence on members of the same species, it is at once obvious that in the first category the differences between the displacement activities and their autochthonous examples are much larger than in the second category. In both categories the incompleteness and superposition of autochthonous elements can be observed, but the releaser group has something in addition. It may even be impossible to recognize a releaser as a displacement activity at all, until comparison with less specialized movements in closely related species reveals its origin. Comparison here renders essentially the same service as in morphology: it may reveal homologies. The "same" displacement activity is often found in all members of a group of closely related species, and the differences between species can often be shown to be due to adaptive radiation. Thus Lorenz (1935) reports that all cranes show displacement preening in hostile situations. In the Manchurian crane, however, the threat behavior is so different from preening that nobody would interpret it as such, if comparison did not show that it is only an extreme case of displacement preening; it is connected with species in which the movement is obviously displacement preening by forms which are (in this respect) intermediate. Similar conditions can be observed in the sticklebacks where the movement of ventilating the eggs ("fanning") is used as an outlet of a thwarted sexual urge. In one species these movements are so different from true fanning that they could hardly be recognized without comparison with other species.

These facts have led to the hypothesis that such displacement activities as have the function of releasing responses in other individuals have acquired it secondarily. This new function must have started a new evolutionary development during which the displacement activities became increasingly better adapted to it. This evolutionary development I have called "ritualization," following Huxley (1923). The nature of the process itself is not known, although obviously selection has to do with it. Its results however are clear, and a study of these results, or the differences between strongly ritualized displacement activities and non-releasing displacement activities, will enable us to describe what principles of change have been involved.

In my previous papers on the subject (1940, 1947) I had not yet clearly realized the difference between ritualization as the secondary evolutionary change, and superposition of autochthonous elements. Much of what I considered then to be ritualization is in reality, I think, due to super-

position. The distinction is essential, because superposition may be quite independent of evolutionary change. Because I realized the importance of superposition only recently (having completely forgotten that I mentioned it in my 1940 paper), I have at present no clear idea of what ritualization comprises. Some facts, however, stand out clearly.

Morphological support. First, ritualization implies the development of conspicuous morphological structures which are demonstrated by the displacement activity. The best-known examples are found among ducks (Lorenz, 1941). The male mandarin duck has, among its dark green secondaries, one in which the inner vane is extremely broadened and orange colored. This huge orange flag stands out permanently, and the displacement preening of the courting drake is nothing but an emphatic touching of this vane with the bill.

Exaggeration and simplification of the movement. The development of such a conspicuous structure runs parallel with an adaptive change in the displacement movement itself. This is not only obvious in the mandarin duck, but also in the garganey. Here the primary coverts form a conspicuous light-blue patch. Whereas in most ducks the displacement preening brings out the speculum, the bill touching the inner side of the wing, the garganey does not touch the secondaries, nor is the wing lifted to allow the bill to preen its inside, but the bill points at, or actually touches, the blue patch. In these cases the change in the movement is an adaptation to the function of showing off a conspicuous structure.

The movement can also undergo changes serving to make the movement itself more conspicuous. This is done by exaggerating the movement by slowing it down and by increasing its amplitude. Instances may again been found in the ducks, and also in pigeons. For instance, Craig (1909) reported that the blond ring dove male "shows eros, by a certain spasmodic preening of the inside of the wing" (p. 67).

So far as our knowledge goes, it seems that, in the process of ritualization, certain elements are exaggerated, other elements tend to disappear entirely. Ritualization therefore is addition as well as simplification; in short, it is schematizing.

All these changes seem to aim at one end: adaptation to the responsive capacities of the reacting individual. It is becoming more and more obvious that innate behavior usually responds to "sign stimuli," to only a few aspects of the total situation. The social releasers seem to be "materialized sign stimuli"; as a result of adaptation to this type of responsiveness. It is in line with this that releasers seem, perhaps always, to release innate, not conditioned, responses.

The differentiation of displacement preening in ducks by ritualization in directions different in each species has presumably to do with the demand of specificity typical of all social releasers, and particularly those which act as sexual isolating mechanisms.

Neurophysiological "emancipation." Ritualization of a displacement activity, resulting in an increase of the difference between it and its original example, has of course neurophysiological implications. When the movement changes through ritualization, this means that the underlying nervous mechanism changes and thus becomes different from that of its example. In this way ritualization brings about a kind of emancipation. The further ritualization proceeds, the more the movement loses its displacement character and becomes an element of the drive which uses it as an outlet. It is of course impossible to draw a line between what is "still" a displacement activity and what is "already" an independent element of the drive which uses it, unless one uses arbitrary criteria. The only thing one can say in such cases is that a movement was originally a displacement activity.

The study of ritualization therefore reveals to us a way in which "new" behavior elements may appear during evolution. Before an activity is ritualized, its nature as a derived movement may be easily recognized. Through gradual adaptive change it may become so different from any other behavior element that eventually it ceases to be a derived movement and becomes a "new" type of behavior.

Conclusion

Although it will, I hope, be clear that the available evidence is still fragmentary, and that continued, systematic research is desirable, what evidence I have been able to present seems to be sufficient to form, with some confidence, a theory on the nature of displacement activities.

Two aspects seem to be essential: the "irrelevant" nature of displacement activities, and their dependence on excess of drive. The irrelevance, or

the fact that the movement shown does not belong to the executive pattern of the drive which is activated, making the movements to appear "out of context," is, as the name indicates, the very essence of the concept. It is the irrelevance which makes us single out these movements as something requiring explanation and is the phenomenon to be explained. It is therefore highly confusing to label an activity as a displacement activity when it is not certainly irrelevant, or worse, when it is clearly not irrelevant. Because the concept has become popular it is now often handled in this uncritical and loose way. This, as Heinroth (1944) pointed out, only tends to blur the whole issue. The confusion to which this dropping of the basic criterion leads is well illustrated by the following passage quoted from Armstrong (1950): "Is the persistent display... of an ocellated turkey, *Agriocharis ocellata*, which I have seen displaying persistently while alone in its cage, to be regarded as normal, overflow, or displacement activity? The display is normal in so far as the movements are similar to those of a bird in normal circumstances. It can be regarded as overflow activity to the extent that it finds expression when the stimulus from the perceptual field is suboptimal; and it can be considered a displacement activity if we suppose that its sustained character arose as a result of the prolonged absence of the female, and it can then be ascribed to the absence of an external stimulus-link" (p. 374). Of course, only analysis can settle which of the three explanations is correct. The persistent display while alone in the cage must be considered overflow display and not normal display if analysis shows, as we may expect, that display in the absence of a female is exceptional. Only thorough study can tell us that, but once we know, it is no longer a matter of taste whether one calls the display normal or an overflow activity. Whether it was a displacement activity or not could only be judged when we had indications about the nature of the bird's motivation at that time, so that we knew whether the activity was "fed" by its own or by another drive. By concluding that an activity must be a displacement activity because of the absence of an "external stimulus-link," Armstrong is reversing the argument. It is true that displacement behavior is sometimes dependent upon absence of a stimulus, but the reverse is of course not true. Whether "displaying persistently while alone" is displacement activity or not depends upon whether the display is a movement belonging to the activated drive or not, and it takes study to find that out.

Because such unanalyzed and incidental observations are used as arguments again and again in Armstrong's and in other discussions, it cannot be stressed too much that a detailed knowledge of the whole behavior pattern is an absolute prerequisite for the critical interpretation of an alleged displacement activity. One needs to know to which of the executive patterns an activity belongs, and also which drive is activated at the moment the activity is seen. This is only possible after prolonged observation, and therefore incidental observations are almost worthless. True, the form of the movement can often be recognized at a glance; but to know which drive is active at the moment requires more than a glance.

The uncertainty in the case cited by Armstrong is due to the absence of these analytical data. To reason, as Armstrong has, that this uncertainty is due "not to deficiencies in our observation or analysis but to basic similarities" (p. 375) is to cover up dissimilarities where analysis shows them to exist. It is quite correct to stress basic similarities where thorough study proves them to exist, but it is confusing when it is done on the basis of absence of evidence. There is an enjoyable synthetic trend in modern science to see the relative value and the artificial nature of many partitions, but it is deplorable wilfully to ignore criteria of discrimination or to neglect the search for them. We have seen that displacement activities which have releaser function tend, through ritualization, to lose their allochthonous character and to become autochthonous. In this respect, therefore, no sharp boundary can be drawn between displacement and autochthonous behavior. It is also true that displacement-sleep during a fight is a more extreme case than displacement-nesting, because nesting and fighting both belong to the major reproductive drive, whereas sleep does not belong to it. Sleep therefore can be said to be "more irrelevant" in a fight than nest-building. But all this does not in the least relieve us from the need to distinguish between displacement and autochthonous behavior.

Concluding, I propose that the concept of displacement activity be defined in the following way: "A displacement activity is an activity belonging to the executive motor pattern of an instinct other than the instinct(s) activated."

The analysis carried out by Kortlandt and myself allows us to add a second criterion: there must be a surplus of drive. Although I must admit that there are many cases known, or rather half-known, where the irrelevance of the activity is clear but where there is uncertainty about the existence of an excess of drive, the excess has been demonstrated in the more thoroughly studied cases, and it seems probable that it is a general feature of displacement activities. However, this is a hypothesis about the causation, while the irrelevance is a matter of observed fact. I therefore suggest that the definition given above should continue as follows: "A displacement activity seems to appear when an activated drive is denied discharge through its own consummatory act(s)." It is possible to describe at least two conditions which can prevent autochthonous discharge, namely, conflict between antagonistic drives, and absence of indispensable releasing stimuli, but it seems possible that future study of unanalyzed cases will reveal other causes.

III. INTENTION MOVEMENTS

Intention movements as expressions of low motivation

In the introductory sketch of the theory of innate behavior I pointed out that certain behavior elements may appear in varying degrees of intensity. Up to now I have been discussing mainly the outcome of motivation of high intensity. We must now consider low-intensity movements, for they are not only very common, but they are also another source of derived movements.

When a song bird, or a pigeon, or a duck, is flying off, it starts by jumping up into the air, so as to be as far away from the ground as possible before the wings come into play. Daanje (1950), who has studied various aspects of bird locomotion in detail, has described how in preparation for the hop the bird not only bends the "heel"-joints, but also the hip-joints (bending the front half of the body downward, and lifting the hind half); further, it withdraws the neck, lifts the wings slightly away from the body, and erects the tail. In the actual take-off, the action of all these parts can be compared with a loosely coiled spring that is relaxed after having first been pushed in. "The maximum effect is reached when the stretching is performed by the whole spring. In much the same way, a leaping bird does not confine the stretching to the legs but uses the muscles of legs, body, and neck" (p. 50).

As remarked above, many behavior patterns, even relatively simple ones, consist of introductory appetitive behavior followed by one or more consummatory acts. In many cases the appetitive behavior consists of going toward something, or of going away from something. In other words, many types of appetitive behavior consist of directed locomotion. This is why incomplete movements caused by a drive of low intensity, are in most cases just incomplete locomotory movements. In the case of flying, hopping, or walking (which is nothing but a kind of alternate hopping of left and right half of the body), low-intensity movements may be no more than the first (withdrawing), or the first followed by the second (stretching) phase of the jump. Every observer knows these half-hearted starting movements; I need not give more examples. They must not necessarily be locomotory movements; I refer to the description given of the various grades of low-intensity sand digging of the three-spined stickleback.

Heinroth called attention to these incomplete movements long ago (1911); he named them intention movements ("Intentionsbewegungen"), because they betray to the observer what the animal is "intending" to do. Lorenz (1941) gave a detailed account of some of these intention movements in surface-feeding ducks, but on the whole they have received less attention than displacement activities. Yet many field observers have a detailed knowledge of intention movements and use them to a great extent, often unconsciously. Especially in the beginning of the reproductive season intention movements may be very common, and the ability to recognize them is of fundamental importance for a correct interpretation of the drives which govern the behavior at a given moment.

In an important paper, Daanje (1950) showed that by a detailed descriptive study of complete movements it is possible to recognize intention movements with more precision and more certainty, and he showed that intention movements are even more common than hitherto recognized. It is unnecessary to give a summary of his highly stimulating account here; for a critical appreciation it is necessary to read the original paper.

It need scarcely be emphasized that although intention movements are formally similar to, and may even be identical with, displacement activities (both showing the same kind of incom-

pleteness), they differ basically as regards the underlying causes: intention movements are autochthonous movements.

Ambivalent combinations of intention movements

Above, I described the upright threat posture of a herring gull and interpreted it as the simultaneous combination of the intention movements of attack and withdrawal. I believe that such ambivalent combinations of the intention movements of two different, antagonistic patterns are much more common than is recognized at present. In several cases it is easy to recognize the two components, especially when they are linked in succession. This is the case in the "pendulum duels" which I described above. In the three-spined stickleback, the tendency to attack a female entering the territory, and the tendency, aroused simultaneously, to lead her to the nest (the appetitive behavior of egg-fertilization, or mating) are combined into a movement which at first glance does not give the impression of being a "derived" movement at all. As a matter of fact, we had seen it many thousands of times, season after season, before we became aware of its ambivalent nature. It would be very worth while to study various forms of display from this point of view, because it could give us important information about the nature of the animal's motivation.

Ritualized intention movements; parallel evolution of displacement and intention movements

It is not at all surprising that many animals have evolved, on the instinctive plane, the same ability as the bird watcher on a higher psychological level, namely, that of recognizing the nature of another individual's motivation by the latter's intention movements, and that, therefore, intention movements often have releaser function. In fact, this is much less surprising than responses to displacement activities, and I believe that displacement activities could only acquire releaser function because they often alternate with autochthonous movements.

Now these intention movements which have acquired releaser function have clearly undergone an evolutionary change of the same type as displacement activities; they have been "ritualized." On the whole, this ritualization seems to have followed the same lines in both cases, which supports our hypothesis that ritualization is adaptation to the releaser function.

Morphological support

As in displacement activities, conspicuous morphological features have evolved which accentuate the movement. This is particularly obvious in one of the courtship movements of ducks, called by Lorenz "das Kurzhochwerden" ("shortening-up posture"). As examples I reproduce two of Daanje's pictures, redrawn after Lorenz, of the mallard (Fig. 10) and the pintail (Fig. 11), respec-

FIG. 10. THE "SHORTENING-UP POSTURE" OF THE MALLARD
After Lorenz, 1941.

FIG. 11. THE "SHORTENING-UP POSTURE" OF THE PINTAIL
After Lorenz, 1941.

tively. According to Daanje, this movement is derived from the starting position before the jump. The movement not only displays the wing-speculum (it is surprising in how many movements this takes a part) but also the tail and its base, and thus shows off several conspicuous features in this region. The gaudily colored triangles under the tail are expanded by ruffling the plumage locally, and it is certainly no accident that the upper tail coverts of the mallard are curled, and that the

pintail has developed the elegant tail from which it has got its name.

Many of the grotesque courtship postures of gallinaceous birds seem also to be derived from the huddled first phase of the hop, (showing the tendency to proceed towards the female), and the variety of adornment used for demonstration in these displays is simply bewildering.

Further adaptation of the movement to the demonstration function

As with displacement activities, there has been in intention movements a parallel evolution of the movement itself, serving to perfect the demonstration of the color. The threat-display of the robin, so well known since the work of Lack (1939), is believed by Daanje to be derived from the huddled phase of the hop. Subsequent or parallel evolution has added a curious orientation component to it: the bird turns the red breast towards the opponent, whether it is to the left or to the right, above or below.

Exaggeration and simplification

Again, as in displacement activities, the movement can undergo changes which make it more conspicuous by itself; this is often an alternative to the development of conspicuous morphological structures. Thus the garganey and the Chilean teal exaggerate parts of the movement (throwing back the head in the former, lifting the breast in the latter). This coincides with a regression of other elements of the movement, such as, in these cases, the lifting of the tail. Probably this exaggeration of parts of the movement at the cost of other parts is the same phenomenon as that called "shifting of thresholds of component elements" by Daanje. As in displacement activities, therefore, ritualization may simplify the pattern, thus adapting it to send out simple but conspicuous "sign stimuli."

Loss of coordination

Finally, Daanje mentions loss of coordination between components as a principle of ritualization of intention movements. One very common form of coordination is synchronization, absolute or relative (von Holst, 1937), of the various parts of the movement, such as those of the tail, the wings, the legs, and the neck. Ritualization may cause these parts to "get away" from the sychronizing influences of the central nervous system, "allowing" them, so to speak, to have their own tempo independent of those of the other elements. I do not at present know of similar phenomena in displacement activities, but I have never studied them from this point of view.

These few remarks may suffice to indicate the close parallels that seem to exist between the ritualization of displacement activities and that of intention movements. Further detailed study is promising. The work done so far is no more than a first tentative step.

IV. "REVERSED" MOVEMENTS

One of the elements of courtship of the black-headed gull is "head flagging." When sex partners, or prospective mates meet, they stretch their necks and turn the head away from each other with a sudden, jerky movement. This has been interpreted as the reverse, or opposite, of the "forward display," one of the species' threat postures, which consists of a lowering of the head while the beak is pointed forward. This threat gesture is made more conspicuous by the brown face. It is characteristic of the head flagging that instead of showing off the weapon (the bill) and the brown face, it conceals them. It is supposed that this movement acts as an appeasing gesture, because it is exactly the opposite of the threat posture. Similar appeasing gestures, which are really the opposite of threat gestures, are found in many species; since the bill (or in the case of mammals the teeth) are usually shown off in threat, the appeasing ceremonies often consist of turning the occiput towards the opponent (Tinbergen and Moynihan, 1952).

V. TOWARDS A BETTER UNDERSTANDING OF DISPLAY

Not so long ago there was an enormous gap between our understanding of "ordinary" activities such as feeding and nest building on the one hand, and all kinds of display on the other. It was relatively easy to understand not only what useful purpose the first type of activities served, but also something of their causation. Internal factors were known to be influential, and were named drives, instincts, urges, or the like. Moreover, it was known that the behavior was to some extent a reaction to stimuli emanating from the outside object to which the activity was related. But all kinds of display were much less easy to understand, as regards both their function and their causation. Displays were admittedly beautiful and striking, or they were found to be "curious,"

"remarkable," "odd," and so on, but about their functions no more was known for a long time than that they were somehow stimulating or pleasing to the female, and were therefore enhanced by sexual selection.

This all has changed. We now begin to understand the function of displays, their relation with underlying causes, and their evolution.

Functions of display

Many different functions of display have been discovered. Some serve as threat or intimidation, some serve to stimulate individuals of the other sex, to attract them or to raise their sexual drive generally. It has been suggested by Huxley (1914) that some serve to strengthen the pair bond. There are further displays which serve to tie the partner to the nest site (Tinbergen, 1935). Other displays have a "diversionary" function (Armstrong, 1949), and so on. It is Lorenz's merit to have seen the common element in all these displays: they are "social releasers" ("Auslöser"); they are all adapted to the function of sending out stimuli to which other individuals react, usually innately. The reaction is sometimes very simple, immediate, and overt, but in many cases it is internal, a gradual change, in a positive or a negative sense, in the intensity of a drive, which does not at once express itself in overt action, but which increases or decreases the readiness to react. In such cases the releaser function is less obvious and has even been doubted. The term could perhaps better be replaced by "signal" or some such term to prevent these misunderstandings; this, however, does not impair the value of the all-embracing conclusion that all displays elicit specific reactions in other individuals. In most cases these "reactors" belong to the same species; they are either sex partners, or social companions, or parents, or chicks. In the case of diversionary and defence displays they affect predators and are adapted to this function in fundamentally the same way. They either release flight or withdrawal, or, as in diversionary displays, they release pursuit.

In a very valuable paper, Baerends (1950) has shown that there are many more types of releasers with an interspecific function than those known to exist in birds; many insects and plants have evolved behavior or structures which have in common the one feature that they are all adaptations to the releaser function.

Whether intraspecific releasers in birds do more than effect changes in the reactor's nervous system and effect "somatic" (endocrine) changes as well, as has been suggested by Darling (1938), is still undecided, although it seems probable in some cases.

Some authors mention displays serving "recognition" as a function separate from the releasing or stimulating function. This is a confusion of thought and of terminology. When a certain display releases a reaction in another bird which cannot be released either by an individual of another species or of the other sex, this specific display enables the reactor to "recognize" the displaying individual as one of a class, say, as a sexually active male of the same species. "Recognition" is a descriptive term, indicating that an animal reacts to one special type of display and not to others. The female mallard reacts specifically to the mallard drake's display and not to others. Another and legitimate way of saying the same thing is to state that she "recognizes" the displaying bird as a mallard drake. The more specific and selective the reaction to a releaser is, the more we are inclined to speak of "recognition." But these differences of degree exist in the effect of the releaser just as well as in the precision of the "recognition," and every display can be said to serve recognition with as much justification as it can be said to serve the release of reactions. If "recognition" is used to indicate the subjective state accompanying selective response, the term is the exact subjective counterpart of the ethological term "selective response." On the highly integrated level of behavior we can use both ethological (biological) and psychological (subjective) terminology (at least when we believe in projecting our own subjective experiences into animals); they run parallel. A courtship display can be said to release a sexual reaction and to raise sexual emotion; an intimidating display can be said to release escape or withdrawal and to cause fear. But to say that one type of display causes escape or withdrawal, and another type causes fear, is to make a distinction on the basis of two different criteria. The result is that phenomena studied from both angles will be discovered to belong in both categories, and that only such phenomena as have been studied from one of the two angles can be distinguished, not because they are different, but because we happen to see only one of our criteria in one case, and the other

criterion in the other case. One could just as well divide tumblers into two categories, one that serves to contain liquid, and another that is beautiful.

The causes of display

A second step in the understanding of display is the recognition of so many types as displacement activities or intention movements, for the analysis of these types gives us an idea of the causes underlying display. Display in aggressive behavior and in sexual behavior baffles us because it seems as if it does not follow the relatively simple rules that apply to "ordinary" behavior. The pattern of the feeding drive can be described rather satisfactorily as a series of appetitive behavior patterns followed by one or more consummatory acts—searching for prey, going towards it, catching it, killing it, eating it. But this framework cannot be applied at first sight to all these displays. An aggressive gull does not merely go towards an opponent and attack it, but it adopts an upright threat-posture, does some grass-pulling, and chokes. It may even do all this instead of attack. Our analysis has enabled us to see that the general scheme can certainly be applied, and that the simultaneous activation of two drives causes complications which in themselves can be understood on the same general principles as hold for any "ordinary" kind of behavior.. Ambivalent combinations of low-intensity movements, and displacement activities arising from strong but thwarted motivation ("tension") are the result of this complicated situation. Hinde (1951) has shown convincingly that the many types of aggressive behavior of the great tit can be understood in the same way.

Further, the same principles have been applied successfully in the unravelling of the mating behavior of the three-spined stickleback (to be published elsewhere). It has shown that mating behavior can be understood as well as aggressive behavior by applying the same principles. In the three instances mentioned (herring gull, great tit, stickleback), *all* originally inexplicable elements have been proved to be derived movements of the types discussed in the present paper.

Such complete analyses have been attempted only in these few cases. All the other evidence mentioned in the present paper applies to isolated parts of display. It is therefore still impossible to say that all display will, upon closer inspection, be proved to be nothing but combinations of displacement activities and intention movements, in simple or more integrated form—although in the light of the analyses of the herring gull, cormorant, ducks, sticklebacks, and tits one gets that impression.

The main reason why it is as yet impossible to say whether these two categories exhaust the possibilities is the fact that ritualization must have changed so many derived activities into "new," still puzzling forms. To unravel these, detailed study of closely related species will be necessary. Such study, leading to a clearer insight into the nature of the drives underlying these complicated behavior patterns, and to a picture of surprising simplicity compared with the baffling complexity of the overt behavior, is highly rewarding.

The evolution of display

It is curious that, through the discovery of ritualization, the study of the evolution of innate behavior patterns has proceeded farther with derived movements than with "ordinary" behavior. This is of course mainly owing to the change of function, from merely relief of impulses ("safety-valve") to releaser function. Even here, however, the study of evolution is still in its infancy. It has just been possible to indicate, very vaguely, some "principles of ritualization." Further comparative study, in which (1) the origin, (2) the mixture with other elements prior to evolution as a releaser (superposition of autochthonous elements, and addition of intention movements of other drives, respectively), and (3) the later changes will have to be well distinguished, will doubtlessly reveal much of extreme interest. It is very probable that comparison will need to comprise not only closely related species, but different subspecies of single species as well.

Thus the study of display has entered a most fascinating phase. The work of the last decade or two, itself based on much preparatory work by Whitman, Heinroth, Selous, and Huxley (to name only a few of the most important pioneers), has been just sufficient to make us see along what lines further study can proceed.

LIST OF LITERATURE

ARMSTRONG, E. A. 1947. *Bird Display and Behaviour*. Cambridge: at the University Press.

——. 1949. Diversionary display. *Ibis*, 91: 88–98, 179–188.

——. 1950. The nature and function of displacement activities. *Sympos. Soc. exp. Biol.*, 4: 361–387.

BAERENDS, G. P. 1950. Specializations in organs and movements with a releasing function. *Sympos. Soc. exp. Biol.*, 4: 337–361.

BERGMAN, G. 1946. Der Steinwälzer, *Arenaria i. interpres* (L.), in seiner Beziehung zur Umwelt. *Acta zool. fenn.*, 47: 1–151.

CARPENTER, C. R. 1933. Psychobiological studies of social behavior in Aves. II. The effect of complete and incomplete gonadectomy on secondary sexual activity, with histological studies. *J. comp. Psychol.*, 16: 59–98.

CRAIG, W. 1909. The expression of emotion in the pigeons. I, The Blond Ring-Dove (*Turtur risorius*). *J. comp. Neurol. Psychol.*, 19: 29–80.

DAANJE, A. 1950. On locomotory movements in birds and the intention movements derived from them. *Behaviour*, 3: 48–99.

DARLING, F. FRASER. 1938. *Bird Flocks and the Breeding Cycle.* Cambridge: at the University Press.

EDWARDS, G., E. HOSKING, and STUART SMITH. 1948. Aggresive display of the oystercatcher. *Brit. Birds*, 41: 236–243.

GOETHE, FR. 1937. Beobachtungen und Untersuchungen zur Biologie der Silbermöwe auf der Vogelinsel Memmertsand. *J. f. Ornithol.*, 85: 1–119.

HEINROTH, O. 1911. Beiträge zur Biologie der Anatiden. *Verh. 5. Intern. ornithol. Kongr., Berlin.*

——. 1944. Uebersprungbewegung. *Ornithol. Monatsber.*, 52: 92–94.

HESS, W. R. 1944. Das Schlafsyndrom als Folge dienzephaler Reizung. *Helv. physiol. Acta*, 2: 305–344.

HINDE, R. 1952. The behaviour of the Great Tit (*Parus major*) and other related species. *Behaviour*, suppl. (in press).

HOLST, E. VON. 1937. Vom Wesen der Ordnung im Zentralnervensystem. *Naturwiss.*, 25: 625–631, 641–647.

HOLSTEIN, V. 1927. *Fiskehejren.* Munksgaard, Copenhagen.

HOWARD, H. E. 1929. *An Introduction to the Study of Bird Behaviour.* Cambridge: at the University Press.

HUXLEY, J. S. 1914. The courtship habits of the Great Crested Grebe (*Podiceps cristatus*); with an addition to the theory of sexual selection. *Proc. zool. Soc. Lond.*, 491–562.

——. 1923. Courtship activities in the Red-throated Diver (*Colymbus stellatus* Pontopp.); together with a discussion on the evolution of courtship in birds. *J. linn. Soc. Lond.*, 25: 253–292.

KIRKMAN, F. B. 1937. *Bird Behaviour.* Nelson, London-Edinburgh.

KORTLANDT, A. 1940a. Eine Uebersicht der angeborenen Verhaltensweisen des mittel-europäischen Kormorans (*Phalacrocorax carbo sinensis* Shaw and Nodd.); ihre Funktion, ontogenetische Entwicklung und phylogenetische Herkunft. *Arch. néerl. Zool.*, 4: 401–442.

——. 1940b. Wechselwirkung zwischen Instinkten. *Arch. néerl. Zool.*, 4: 442–520.

LACK, D. 1943. *The Life of the Robin.* Witherby, London.

LIDDELL, H. S. 1938. The experimental neurosis and the problem of mental disorder. *Amer. J. Psychiat.*, 94: 1035–1041.

LORENZ, K. 1935. Der Kumpan in der Umwelt des Vogels. *J. f. Ornithol.*, 83: 137–312, 289–413.

——. 1937. Ueber die Bildung des Instinktbegriffs. *Naturwiss.*, 25: 289–300, 307–318, 324–331.

——. 1941. Vergleichende Bewegungsstudien an Anatinen. *J. f. Ornithol.*, 89, Sonderheft: 194–294.

——. 1943. Die angeborenen Formen möglicher Erfahrung. *Tierpsychol.*, 5: 235–409.

——. 1950. The comparative method in studying innate behaviour patterns. *Sympos. Soc. exp. Biol.*, 4: 221–269.

MCDOUGALL, W. 1933. *An Outline of Psychology*, 6th ed. Methuen, London.

MAKKINK, G. F. 1931. Die Kopulation der Brandente (*Tadorna tadorna* (L.)). *Ardea*, 20: 18–22.

——. 1936. An attempt at an ethogram of the European Avocet (*Recurvirostra avosetta* L.) with ethological and psychological remarks. *Ardea*, 25: 1–60.

——. 1942. Contribution to the knowledge of the behaviour of the Oystercatcher. *Ardea*, 31: 23–75.

NALBANDOV, A. W., and L. E. CARD. 1945. Endocrine identification of the broody genotype of cocks. *J. Hered.*, 36: 35–39.

NOBLE, G. K., and M. WURM. 1943. The social behavior of the Laughing Gull. *Ann. N. Y. Acad. Sci.*, 45: 179–220.

PALMGREN, P. 1934. Balz als Ausdruck der Zugekstase bei einem gekäfigten Fitislaubsänger. *Ornis fennica*, 4: 84–88.

PICKWELL, G. B. 1931. The Prairie Horned Lark. *Trans. Acad. Sci. St. Louis*, 27: 1–153.

PORTIELJE, A. F. J. 1928. Zur Ethologie bzw. Psychologie der Silbermöwe, *Larus a. argentatus* Pontopp. *Ardea*, 17: 112–149.

——. 1936. Ein bemerkenswerter Grenzfall von Polygamie bzw. accessorischer Promiskuität beim Höckerschwan. *J. f. Ornithol.*, 84: 140–158.

——. 1939. Triebleben bzw. intelligente Aeusserungen beim Orang-Utan (*Pongo pigmaeus* Hoppius). *Bijdr. Dierk.*, 27: 61–114.

POULSEN, H. 1950. Bidrag til Mudderklirens, *Tringa hypoleucos* (L.), Ethologi. *Vår Fågelvärld*, 9: 4–10.

RÄBER, H. 1948. Analyse des Balzverhaltens eines

domestizierten Truthahnes (*Meleagris*). *Behaviour*, 1: 237–266.

SCHENKEL, R. 1947. Ausdrucks-Studien an Wölfen. *Behaviour*, 1: 81–130.

TINBERGEN, N. 1935. Field observations of East Greenland birds I. The behaviour of the Red-necked Phalarope (*Phalaropus lobatus* L.) in spring. *Ardea*, 24: 1–42.

——. 1936. Zur Soziologie der Silbermöwe. *Beitr. Fortpfl.biol. Vögel*, 12: 89–96.

——. 1937. Ueber das Verhalten kämpfender Kohlmeisen (*Parus m. major* L.). *Ardea*, 26: 22–223.

——. 1939a. Field observations on East Greenland birds II. The behavior of the Snow Bunting (*Plectrophenax nivalis subnivalis* Brehm) in spring. *Trans. linn. Soc. N. Y.*, 5: 1–92.

——. 1939b. On the analysis of social organization among vertebrates, with special reference to birds. *Amer. Midl. Nat.*, 21: 210–234.

——. 1940. Die Uebersprungbewegung. *Z. Tierpsychol.*, 4: 1–40.

——. 1942. An objectivistic study of the innate behaviour of animals. *Biblioth. biotheor.*, 1: 39–98.

——. 1948. Social releasers and the experimental method required for their study. *Wilson ornith. Bull.*, 60: 6–51.

——. 1950. The hierarchical organization of nervous mechanisms underlying instinctive behaviour. *Sympos. Soc. exp. Biol.*, 4: 305–312.

——. 1951. *The Study of Instinct.* Oxford Univ. Press, Oxford.

——. 1952. *The Herring Gull.* Collins, London. (In press.)

——. and J. VAN IERSEL. 1947. 'Displacement reactions' in the Three-spined Stickleback. *Behaviour*, 1: 56–63.

——, and M. MOYNIHAN. 1952. "Head flagging" in the Black-headed Gull. *Brit. Birds*, (in press).

VERWEY, J. 1930. Die Paarungsbiologie des Fischreihers. *Zool. Jb. Physiol.*, 48: 1–120.

WHITMAN, CH. O. 1919. *The Behavior of Pigeons.* Carnegie Inst. Wash. Publ. 257, vol. III. xi + 161 pp.

WILLIAMSON, K. 1950. The distraction behaviour of the Faeroe snipe. *Ibis*, 92: 66–75.

PLANT HORMONES IN THE DEVELOPMENT OF FRUITS

By J. P. NITSCH

Centre National de Recherches Agronomiques, Versailles, France

INTRODUCTION

The fruit not a morphological, but a physiological entity

BOTANISTS have usually classified fruits in multiple types, e.g., pod, drupe, berry, pome, achene, etc. Such a classification, useful as it is from a morphological point of view, tends to make one lose sight of a fundamental characteristic which every layman even tacitly acknowledges when he calls an apple, or a cherry, or a pineapple "a fruit." What, then, is this fundamental characteristic which confers the same name upon these different types? Is it because these structures have a similar origin? No! A cherry derives from the ovary, a strawberry from the receptacle supporting the achenes (the botanical "fruits"), a pineapple from various floral parts grown together with the floral axis. The character which unifies such varied forms and structures is not a morphological, but a physiological one. The fruit obviously develops in connection with the reproductive apparatus of the plant, the flower. Not every floral part, however, is directly related to the formation of the fruit. Neither sepals, petals, nor stamens are indispensable in this relationship, since staminate flowers in monoecious plants such as the cucumber, or dioecious plants such as the date, never produce any fruit. That floral part, the presence of which constitutes the criterion by which we decide to call a certain structure "a fruit," is the ovule. But for the ovule the chain of events which initiate the development of "the fruit" would not take place. This distinction still holds true for fruits which are naturally seedless such as the banana, because in those instances ovule primordia were at least initially present. Even though the layman, for utilitarian reasons, may apply the term "vegetable" to pumpkins, beans, tomatoes, etc., he is quite aware of the fact that these structures come from flowers and contain seeds. We will, therefore, follow the intuition of the layman and define a *fruit* as *the structural entity resulting from the development of the tissues which support the ovules of a plant*.

The problem, then, is to characterize this relationship between the ovules and the fruit. In the past centuries, the assumption has been made that the fruit nourishes the ovules and allows them to develop into seeds. During the last fifty years, experiments have shown that, inversely, ovules may exert an influence upon developing fruits causing them to grow to their full size and form. Whatever the relations between ovules and fruits, they promise to provide the biologist with interesting cases of possible hormonal interactions between one floral part and another. In this paper, one side only of this relationship will be reviewed, namely, the regulation of the development of the fruit, not of the ovule.

It may at once be noted that the bulk of the growth of a fruit occurs after the opening of the flower, and that, in most cases, the failure of pollination and fertilization prevents this development. This well known fact is very suggestive of the type of mechanism involved in the regulation of fruit growth. Pollination and fertilization have, strictly speaking, nothing directly to do with the fruit tissues themselves. There is no fusion of nuclei between pollen tubes and fruit cells. Yet the phenomena occurring in the ovule are necessary to "set" a fruit and to stimulate its development to full maturity. This observation strongly suggests that the relationship between ovule and fruit may be hormonal in nature. Evidence will be presented below to demonstrate this point. Important as pollination may be, it remains true that the tissues of the fruit are formed before the opening of the flower. We will, therefore, examine first the initiation and growth of the fruit tissues before anthesis, and then the effect of pollination and ovular development upon fruit growth. It will thus become apparent that chemical

stimuli for fruit development may come from three sources; (1) the vegetative part of the plant; (2) the pollen; and (3) the ovules (Fig. 1).

Auxins, growth hormones, and growth regulators

Many terms have been used in the literature to designate the substances which will be referred to in the course of this review. It is clear that a special name is necessary to unite the wide variety of compounds which have similar effects on fruit growth. It is clear also that such a name cannot be based on chemical resemblances, but rather that it should be chosen because of similar physiological activities. The author proposes to use the term "auxins" rather than "growth hormones," "growth regulators," etc., for the following reasons. A hormone, as defined by Bayliss and Starling (1904), is an organic chemical which is formed in one organ and transported to another where it effects a special physiological process. An auxin can be a hormone or not, according to the instance involved. It is a hormone in the tip of a plant where it is produced by the apical meristem and the young leaves, and is transported basipetally to stimulate the elongation of internodes and petioles. It is not a hormone in the case of bacteria-free crown-gall tissues proliferating indefinitely in culture because the cells themselves produce the auxin which they need for growth. Conversely, substances other than auxins, thiamin for instance, may be true plant hormones because they are formed in the mature leaves, and are transported to the root and shoot meristems where they participate in the metabolism of these parts (Bonner and Bonner, 1948). If the term "hormone" cannot express adequately the concept of auxin, neither can the phrases "growth substance" and "growth regulator," which are too general; indeed these phrases may include in their concepts substances other than auxins. Thus, vitamins are also "growth substances," and many inhibitors like maleic hydrazide or even arsenite are "growth regulators."

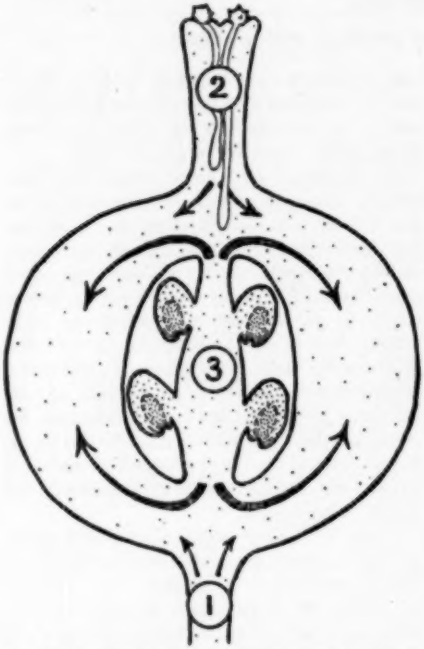

FIG. 1. DIAGRAMMATIC REPRESENTATION OF THREE POSSIBLE SOURCES OF HORMONAL STIMULI ACTING ON FRUIT GROWTH

(1), the vegetative parts; (2), the pollen and pollen tubes; (3), the ovules. Stimuli from petals, stamens, etc., have not yet been demonstrated.

The term ***auxin***—from the Greek "auxein," to grow—was proposed originally by Kögl and Haagen-Smit (1931) to designate a particular substance which had the property of promoting curvature in the *Avena* test (see Went and Thimann, 1937). We will designate as an ***auxin*** an organic substance, active at low concentrations (one thousandth molar or less) in promoting growth by cell enlargement in suitable plant materials, such as stems and petioles. This property can be measured quantitatively in corresponding tests involving determinations of either differential or straight growth (see Thimann, 1948). In addition to the promotion of cellular elongation, auxins can generally bring forth other characteristic responses, such as the stimulation of cambial activity, the initiation of roots, the reversible inhibition of buds, etc.

The same distinction must be made between the generic term "auxins" and the particular substances "auxin a" and "auxin b" as between the generic name "vitamins" and the particular substances "vitamin A," "vitamin B_1," etc. Among the auxins we can distinguish between naturally occurring auxins such as indole-3-acetic acid, phenylacetic acid, cis-cinnamic acid, etc., and synthetic auxins like α-naphthaleneacetic acid, 2,4-dichlorophenoxyacetic acid (2,4-D), etc. The latter are truly "heteroauxins" in the sense given

by Kögl, Haagen-Smit, and Erxleben (1934), but this term should be discarded completely because it has unfortunately been applied to the most universally occurring natural auxin, indole-3-acetic acid. In conclusion, we shall adopt the word *auxin* as a generic term and call, whenever possible, a particular auxin by its specific chemical name.

I. THE DEVELOPMENT OF THE OVARY PRIMORDIUM BEFORE POLLINATION

The scanty information available on fruit physiology prior to flower opening concerns mainly the ovary, to which, therefore, discussion will be confined in the present section.

Initiation of the ovary primordium

The initiation of the ovary primordium involves firstly a change in the physiology of the whole plant from a vegetative to a reproductive metabolism, which results in the production of floral primordia, and secondly the differentiation of ovaries in these primordia. The first and more general step has been adequately reviewed in the symposium of Murneek and Whyte (1948) and more recently in this journal by Leopold (1951). It will only be pointed out here that auxins at least influence the transformation from a vegetative to a flowering status, and that the artificial application of α-naphthaleneacetic acid and similar synthetic auxins stimulates flowering in certain semi-tropical plants like the pineapple (van Overbeek, 1946), the lichee (Shigeura, 1948), and the mango (Cobin, 1951, private communication). More generally, however, applied auxins seem to inhibit flowering, for example, as in *Xanthium* (Bonner and Thurlow, 1949). After formation of floral primordia has been stimulated in the still obscure process generally designated as "floral induction," the rudimentary primordia which are being laid down may develop in various ways according to internal and external conditions.

In dioecious plants, the studies of Correns (1907, 1928) and others (for review, see Allen, 1940) have emphasized the role played by the genetic factors in determining sex—and thus the ability to produce stamens or pistils—in angiosperms. Special sex-chromosomes were described in several species and interpreted as playing a role similar to the heterochromosomes X and Y in animals. In roughly 50 per cent of the genera investigated, however, no recognizable sex-chromosomes could be detected. The formation of an ovary may be under genetical control, but certainly environmental factors can be superimposed upon the genetical constitution and stimulate or inhibit the development of pistils. Thus Buchenau (1903) described the development of stamens inside the "female" flowers of *Melandryum rubrum*; Schaffner (1929, 1936, 1937), various sex reversals in *Morus alba*; Breslavetz (1936), sex reversal in *Cannabis sativa* caused by the short days in winter; Tibeau (1936), the increased percentage of female plants in hemp due to heavy nitrogen fertilizing, etc.

Monoecious plants offer many instances to illustrate the effect which environmental factors exert on the differentiation of ovary primordia. In *Zea mays* it is not only possible to inhibit the formation of male flowers by short winter days (Schaffner, 1930), but also to stimulate the formation of pistils (Schaffner, 1927). In *Ambrosia trifida*, short days (Mann, 1942) or low temperatures (Jones, 1947) greatly stimulate the formation of female flowers. Among monoecious plants, the case of cucurbits is of special interest. Tiedjens (1928), Edmond (1930), and others have shown that climate during the winter months greatly stimulates the formation of pistillate flowers in *Cucumis sativus*, whereas the number of male flowers produced is very low. During the summer the opposite situation prevails. A recent and detailed study of the development of flowering in *Cucurbita pepo* by Nitsch (1950b) and Nitsch et al. (1952) has shown that even though environmental conditions of light and temperature remain unchanged, the quality of the flowers produced varies with time. At first, male flowers only are produced, then a mixture of male and female flowers in which the proportion of female flowers steadily increases until only female flowers occur (Fig. 2). An "index of feminization" can be calculated in order to measure quantitatively the rate of this transformation. More important for the understanding of fruit growth is the observation made on this material that not only the number of female flowers tends to increase with age, but that the quality of these flowers changes also, the ovary becoming larger and larger in successive flowers (Fig. 3.) In fact, the growth of the ovary can proceed so far before the flower opens that it will continue afterwards without pollination occurring. A parthenocarpic fruit is thus produced, representing the ultimate stage of progressive feminization. The importance of this

process for our understanding of fruit growth will become more apparent when we study the cessation of growth of the unpollinated ovary at the time of flower opening. It will only be pointed out now that applied auxins can affect the differentiation of stamens and pistils in cucurbits. Compounds

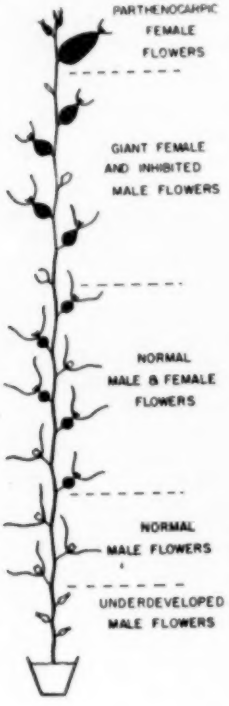

FIG. 2

FIG. 2. PROGRESSIVE CHANGE IN THE TYPE OF FLOWERS PRODUCED BY THE VINE OF CUCURBITA PEPO (VAR. ACORN SQUASH) WHEN GROWN AT 23°C. (DAY), 17°C. (NIGHT) UNDER 8 HOURS OF SUNLIGHT

(From Nitsch, 1950b, and Nitsch et al., 1952)

like α-naphthaleneacetic acid inhibit the development of male flower buds and cause female flower buds to form, as shown by Laibach and Kribben (1949, 1950a, b, c, d) in *Cucumis sativus* and by Nitsch et al. in *Cucurbita pepo* (1952).

In hermaphroditic flowers, the formation of the ovary generally follows the differentiation of the stamens (Payer, 1857), a sequence comparable to the one described for the flowering in cucurbits. Here also development of the ovary can be stimulated or inhibited by appropriate treatments. Howlett (1939), for instance, showed that in the tomato summer days favor the development of large stamens, winter days the growth of the pistil. He correlated stamen development with high carbohydrate content of the plant (1936), and so did Gardner (1923) in his work on dioecism in the strawberry.

Thus the small amount of information available on the differentiation of the ovary indicates that climatic factors such as light and temperature greatly affect this process. In general, short days and low temperatures tend to stimulate ovary

FIG. 3. THE INCREASE IN OVARY SIZE OF FEMALE FLOWERS OF CUCURBITA PEPO (VAR. ACORN SQUASH)

Middle, a normal female flower; Right, female flower with slightly enlarged ovary; Left, female flower with giant ovary.

development. Although too little is known as yet about the biochemical processes affected by climatic factors, it may be pointed out that both auxins and low temperatures promote the development of fruits without pollination, stimulate flowering in the pineapple (van Overbeek and Cruzado, 1948), and promote the formation of female flowers in cucurbits. It thus seems reasonable to suggest that the initiation of an ovary is dependent upon a chain of biochemical events in which auxins play a role.

Growth of the ovary before pollination

Once the ovary primordium has been initiated, it may still be incapable of further development and may disintegrate if internal and external conditions are unfavorable. Thus, in the case of

monocots such as the tulip, the hyacinth, etc., flower primordia may or may not develop further according to the temperature at which they have been stored. A good review of this work, done mainly by Blaauw and coworkers, has been written by Went (in the symposium by Murneek, Whyte, and others, 1948).

Let us assume now that conditions are favorable for the growth of the ovary after initiation of the primordia, and let us examine what is known about the pattern of its development. From his studies in cucurbit fruits, Sinnott (1939, 1945a, b) concluded that growth proceeds at a constant exponential rate before, as well as after, full bloom, slowing down only when fruits approach maturity. He found that the increase in ovary size is accompanied by active cell multiplication before the opening of the flower, but that after pollination growth of the ovary proceeds without appreciable cell division. Finally he was able to correlate the difference in fruit size observed in different varieties of cucurbits with duration of cell multiplication, this process continuing longer after full bloom in large-fruited varieties than in small-fruited ones. In the tomato, Houghtaling (1935) showed that abundant cell multiplication occurs during the early growth of the ovary, but that some cell enlargement is already noticeable shortly before anthesis, while practically all the growth after anthesis is associated with cell enlargement. In tomatoes also, the ultimate size of the fruit is generally determined by the amount of cell multiplication which has occurred in the young ovary. In pome and stone fruits, the same picture seems to prevail. Tukey and Young (1939), in a study of the development of the sour cherry, concluded that practically all the cell divisions in the ovary are to be found before fertilization of the ovules. In the apple, a similar status was described by MacArthur and Wetmore (1941) and by Tukey and Young (1942), and was confirmed by Smith (1950).

Thus, in all cases investigated, it seems that two processes regulate the growth of the ovary: cell division and cell enlargement. Cell enlargement can reach enormous proportions in fruits, and any person who has eaten a piece of watermelon (*Citrullus vulgaris*) can have noticed that, when mature, the cells of this fruit are so large that they can be seen individually with the naked eye. Mitotic activity usually ceases shortly after anthesis. When, however, cell division continues in the ovary after pollination, the fruits obtained often become larger as a consequence of the increased number of cells.

The cessation of growth in unpollinated ovaries at the wilting of the flower

In contrast to the continued growth of the vegetative primordium, one of the most striking facts about the development of the ovary is that it grows regularly until the flower opens and then abruptly ceases to enlarge, unless the ovules are fertilized or a parthenocarpic fruit is initiated. This cessation of growth is not due to any inherent inability of the cells to enlarge since, if fertilization of the ovules has occurred, a normal fruit develops (Fig. 4). The shape of the growth curve of such a fruit (Fig. 5) has the sigmoid appearance characteristic of growth in living plants and animals (Thompson, 1942). We have thus before us the interesting case of plant tissues—the tissues of the future fruit—which are capable of growing but which suddenly stop doing so at the time the flower opens. This fact occurs so usually that the attention of most plant physiologists has been devoted to what factors actually cause fruits to develop after flowering, taking for granted that ovary growth necessarily has been stopped at that time. It is the author's opinion, however, that the important question is not so much "Why does the

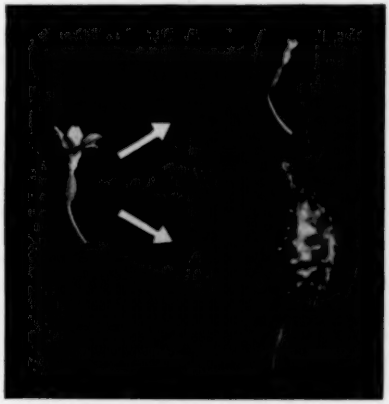

FIG. 4. THE OVARY OF A FLOWER OF CUCUMIS ANGURIA WILL EITHER SHRIVEL, IF NOT POLLINATED (top right), OR WILL DEVELOP TO A FULL-SIZE FRUIT, IF POLLINATED (bottom right)

Both flowers were grown on the same vine at 24°C. (day), 17°C. (night), with 8 hours of sunlight. (From Nitsch, 1950b.)

ovary grow into a fruit?" but rather "Why doesn't it *always* grow into a fruit?" In fact, the work of Nitsch (1950b), and of Nitsch et al. (1952) has recently shown that, in cucurbits at least, it is possible to obtain continued growth of the ovary from its initiation until it has completely developed into a mature fruit by controlling adequately the climatic environment. It becomes appropriate, then, to investigate the factors which could bring about the usual arrest in growth encountered by the tissues of fruits at the time of flowering.

One of the most immediate suggestions involves flower abscission. In many plants, if pollination is prevented, the whole flower drops off. It may thus

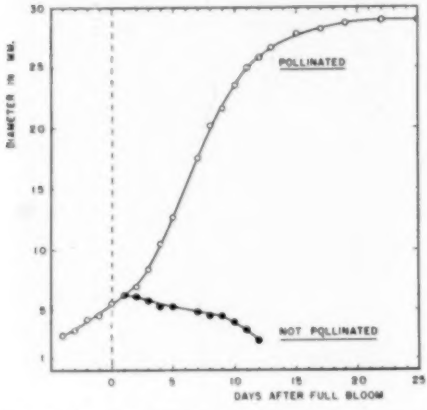

FIG. 5. GROWTH CURVES OF OVARIES OF CUCUMIS ANGURIA GROWN UNDER THE SAME CONDITIONS AS IN FIG. 4

Each curve is the mean of 5 ovaries. (From Nitsch, 1950b.)

be argued that the tissues of the future fruit are perfectly capable of further growth, but are prevented from growing because of a special mechanism which allows the development of an abscission layer in the peduncle of the flower. Such an abscission layer has been clearly demonstrated in the tomato (Kendall, 1918), in the apple (Pfeffer, 1904; MacDaniels, 1937), etc. When pollination is prevented, suberized cells develop in the abscission layer and the flower drops off, thus eliminating the possibility of fruit development. Such a concept seems at first to be hard to prove or disprove, but the difficulty may be avoided by the following experiments. Firstly, there are plants in which no such abscission takes place. The ovaries of the small gherkin (*Cucumis anguria*), for instance, remain attached to the plant for long periods after full bloom (which lasts only one day) even though no pollination has occurred. A comparison, therefore, can be made between the growth habit of pollinated and unpollinated gherkin ovaries (Nitsch, 1950b). The result of such an experiment showed clearly that, whereas the pollinated ovaries grew regularly into full-sized fruits, the unpollinated ones not only did not enlarge from the second day on after flower opening, but soon started to turn yellow and then to shrink as if they were losing water and perhaps also the food which they had gained previously (Figs. 4 and 5). This result indicates that to develop into a fruit an ovary needs more than merely to remain connected with the whole plant. More decisive experiments yet can be contributed to prove this point. Let us choose a flower which possesses an abscission layer, a tomato flower for instance, and keep it artificially connected with an adequate supply of food. This can be done by cutting the flower off the plant and planting it on a nutrient medium (Nitsch, 1949b, c). If the flower has been pollinated before planting, a fruit develops; if, on the contrary, pollination has been prevented, no fruit is obtained, even though the same medium is used, a medium which does not contain any auxin (Nitsch 1950b, 1951a). In fact, it is possible to keep unpollinated tomato flowers on the plant by adequately controlling light and temperature. Thus, unpollinated flowers of Essex Wonder tomatoes were kept on the plant for more than a month after full bloom by growing the plants at 23°C. (day) and 17°C. (night) for 8 hours of full sunlight. Although these flowers remained in healthy condition and the sepals grew in length and in width, no fruit was set. It can be concluded that the maintenance of the ovary on the plant is only a prerequisite for fruit set, not its cause. At the wilting of the flower, growth stops in the ovary even though the connection with the vegetative parts of the plant remains apparently unchanged. The cause of such an arrest in development must, therefore, be sought in the physiology of the ovary itself.

Auxin relationships

Since the famous axiom "Without growth substance, no growth" was first proposed by Went (1928), thousands of experiments throughout the world have supported the validity of this statement

by demonstrating that auxin is indeed a limiting factor in cell enlargement. All conditions being equal, the lowering of the auxin concentration causes cell enlargement to stop, whereas restoration of the auxin supply initiates growth again (if it comes soon enough). It would thus seem appropriate to investigate the auxin level in young flower buds, because a significant drop in this level could account alone for the arrest in growth encountered at the time the flower wilts. Indirect evidence pointing toward a change in the auxin concentration at the time of flower opening has been provided by many workers studying flower movements. Rapid elongation of the flower stalk before flower opening is apparent in many species. More significant is the fact that the growth of the flower stalk ceases at anthesis but resumes afterwards, as shown by Miyake (1904) in *Taraxacum*, by Schulz (1921) in *Papaver*, Oehlkers (1922) in *Tropaeolum majus*, Schmitt (1922) in *Linaria cymbalaria*, etc. A two-peak curve in the rate of stalk elongation is visible in nearly all cases, the minimum coinciding with the opening of the flower. The control of this elongation by the flower has been traced by Söding (1936, 1938) to the amounts of auxin diffused through the peduncle. Young flower buds of *Cephalaria* and *Heliopsis* were found to release appreciable quantities of diffusible auxin as tested by the *Avena* test, whereas no auxin could be obtained from open flowers. Unfortunately, Söding's data are of little value for our investigation of ovary growth since they concern whole flowers in which the measured auxin could have come from the developing stamens. It is known, in fact, that young stamens are very rich in auxin (Wittwer, 1943; Hatcher, 1945); also the phenomenally rapid elongation of the filaments in *Secale* is no doubt a result of this high auxin content (Schoch-Bodmer, 1937). Using flowers without stamens, i.e., female flowers of *Cucumis sativus*, Gustafson (1939b) found also a drop in the auxin content of the flower at the time of flower opening. An attempt to localize further the site of auxin production in the young ovary had already been made by Katunskij (1936) for *Papaver* and *Crepis*. Katunskij found a direct correlation between the auxin content of the ovules developing in the flower bud and the elongation of the flower stalk, the auxin content decreasing to a very low value at the time of flower opening while the peduncle ceased to grow.

Once formed in the flower bud, the ovary will enlarge continuously with accompanying cell multiplication. At the time of flowering, cell division practically ceases and the auxin content of the flower drops. The ovary will then abscise with the flower, or, if it remains attached to the plant, it will shrink and dry out. From its initiation up to full bloom the ovary has been growing on the food supplied by the mother plant. In some way, it now becomes unable to use this food and to grow any further. A new element has to enter the picture. This new element is the pollen.

II. THE EFFECT OF POLLINATION ON FRUIT DEVELOPMENT

Let us again consider the growth curve of a gherkin ovary (Fig. 5). The increase in diameter proceeds at a constant exponential rate, and it is difficult to detect any sudden change in the shape of the curve at the time of pollination. The curve is smooth and regular, as if nothing had happened. Still, if pollination does not take place, growth soon ceases. How then can we distinguish between ovary growth before and after pollination, since one growth period goes so gradually over into the other that it is impossible to say where one finishes and where the other beings?

The breakdown of the growth curve of a fruit into partial processes only requires use of a suitable material. The fruits of tropical orchids, such as *Phalaenopsis* or *Cypripedium*, are particularly slow growing, taking about six months from pollination to maturity. A particular point of interest is the fact that in *Phalaenopsis*, for example, pollen germinates only four days after pollination, and that fertilization takes place 60–70 days afterwards. Using such material, Duncan and Curtis (1942b) were able to demonstrate a two-peaked curve in the rate of ovary enlargement in *Cypripedium*. The first peak may be ascribed to a growth stimulus coming from the pollen, the second to a further stimulus from the developing ovules. This section of the discussion will be concerned with the action of the pollen itself. The role of the ovules will be discussed in the next section.

The action of the pollen on ovary growth is hormonal in nature

What does the pollen do to set a fruit? This is our present problem. In trying to find the answer, let us first observe what happens to pollen after it has reached the pistil of a flower. Pollen grains germinate on a receptive stigma and form long tubes which grow inside the spongy tissue of the

style to reach the ovules. Two male nuclei are discharged inside the embryo sac, where one of them unites with the egg nucleus to form the diploid zygote; whereas the other, in the normal type, fuses with the two polar nuclei to give rise to the primary endosperm nucleus which is therefore triploid. It is difficult, at first view, to visualize how such processes, which involve only the ovules, can have any direct effect upon the growth of maternal tissues like an ovary or a receptacle, etc.

Yet pollination may stimulate the growth of a fruit even though pollen fails to ensure seed development. In certain incompatible crosses (Yasuda, 1934a), seedless fruits may be produced. In other words, the growth of pollen tubes inside the style can by itself cause an ovary to develop into a fruit, even though no fertilization occurs. This phenomenon has been termed by Winkler (1908) "stimulative parthenocarpy." This stimulation of ovary growth is in some cases visible even before the pollen has germinated, as happens for tropical orchids (Duncan and Curtis, 1942a). It thus appears that neither fertilization nor even pollen germination is indispensible for fruit formation. It was also while working with orchids that Fitting (1909) started to investigate the effect of pollen on the swelling of the ovary. By using dead pollen and, later, aqueous pollen extracts, he was first to demonstrate that stimulation of ovary growth through pollen is achieved by means of a chemical substance. Thus, the action of one tissue—the pollen—upon another tissue—the future fruit—is exerted by mediation of a chemical stimulus which we can truly call a hormone according to the definition of Bayliss and Starling cited in the introduction.

Fitting (1909) showed also that extracts of *Hibiscus* pollen could achieve the same effect as orchid pollen, which indicated that the substance involved was not very specific to the orchid family. Indeed Yasuda (1934a, 1934b, 1939) and Gustafson (1937) proved by large-scale experiments that pollen extracts of many apparently unrelated genera were active in stimulating fruit formation in unpollinated ovaries.

Another, and most important feature of pollen extracts, was discovered by Laibach (1932), Laibach and Maschmann (1933), and Thimann (1934), namely, that pollen promotes curvature in the *Avena* test. This test is well known to be rather specific for auxins of the indole-3-acetic acid type. The auxin effects of pollen extracts are also visible on the bean seedling, where they may cause considerable cell elongation and the formation of small tumors (Laibach, 1933a; Mitchell and Whitehead, 1941) or the bending of the stem if applied unilaterally (Wittwer, 1943). Could it then be said that auxins are responsible for fruit set? This question was answered affirmatively by the decisive experiments of Gustafson (1936), who produced full-sized fruits from unpollinated ovaries by treating them with various synthetic auxins. These results have been amply confirmed by numerous subsequent workers, and a new branch of horticulture has sprung from these investigations. The role of synthetic auxins in stimulating parthenocarpy (i.e., fruit development without fertilization) will be discussed in the fourth section of this review.

Auxin relationship in pollen

The total amount of material provided by the pollen to the ovary is very small, a fraction of a milligram perhaps. This situation immediately raises the question: Does pollen contain enough auxin? Gustafson (1937) induced fruit formation with pollen extracts, but his paper does not state how much pollen was used. It is not unlikely that perhaps a hundred times more material was necessary to set a fruit with pollen extracts than is actually used in nature. After the calculations of van Overbeek, Conklin, and Blakeslee (1941) had raised the question of this quantitative relationship, it became more and more apparent that although pollen contains auxin, it does not contain enough auxin to account for fruit setting. Muir (1947), Nitsch and Gustafson (1948, unpublished), and Larsen and Tung (1950) found very little auxin in the pollen of the species investigated (*Nicotiana*, *Anthirrhinum*, *Papaver*, *Lilium*, *Pyrus malus*, etc.). On the other hand, Muir (1942) had shown that, at least in *Nicotaina tabacum*, appreciable quantities of auxin diffused down the pedicel two days after pollination. There seems little doubt that one of the effects of pollination is to provide the ovary with an appreciable amount of auxin. The question is to determine where this auxin comes from. To answer this question, Muir (1947) has performed alkaline and acid hydrolyses of pollen samples and found that more auxin could be extracted after these treatments than without. Unfortunately, the physiological meaning of the auxin obtained by such means is not clear; in fact, alkaline hydrolysis leads to definite artifacts (Schocken, 1949), and so can digestion by proteo-

lytic enzymes (Nitsch, Hackett, and Thimann in press). The idea that auxin is set free during germination of the pollen and growth of the pollen tubes has also been presented by Muir, on the basis that more auxin can be extracted from pollen tubes than from pollen grains in *Nicotiana*, *Anthirrhinum*, *Cyclamen*, and *Datura* (Muir, 1947). Similar results were obtained with *Papaver* and *Colutea* by Nitsch and Gustafson (1948, unpublished). In view, however, of the studies of Nitsch et al. (in press) showing that maintenance of strict sterility is of crucial importance in tests of that kind, and considering that use of ripe but perfectly uncontaminated pollen is difficult to achieve, one may reserve one's judgment about this auxin "set free" until new experiments are performed along this line.

A very interesting experiment has been performed by Muir (1947). Tissues of tobacco ovaries and pollen were incubated separately and together in phosphate buffers at 37°C. for 24 hours, and then extracted for auxin. In general, little or no auxin was obtained when either of the tissues was incubated separately, whereas appreciable quantities of this substance were detected when the two tissues were incubated together. It thus seemed that the genesis of auxin in the ovary following pollination could be interpreted by assuming that one tissue was providing an auxin-producing enzyme, the other the substrate for it. The only enzyme known to produce an auxin is the one described by Wildman, Ferri, and Bonner (1947) for spinach leaves which transforms L-tryptophane into indole-3-acetic acid. Nitsch and Gustafson (1948, unpublished) germinated pollen on artificial media with or without L-tryptophane and found that in *Lilium regale* and *L. canadense* appreciable amounts of auxin were formed only if L-tryptophane was added to the medium. This held true when breis of non-germinated pollen were incubated with tryptophane. Pollen of *Pinus ponderosa* gave similar results (Nitsch, 1950b). After these experiments, the author proceeded to repeat Muir's experiments on *Lilium regale*. As Table 1 shows, both the ovary and the pollen tissues produced auxin when incubated with tryptophane. However, when incubated together without tryptophane, no auxin could be extracted. It thus became increasingly suggestive that plant tissues, incubated under nonsterile conditions, produce auxin if appreciable quantities of tryptophane are available. This is supported by Muir's observation that a pH of 8.0 allows larger amounts of auxin to be produced than a lower pH. A slightly alkaline pH very much enhances the formation of auxin from tryptophane (Nitsch et al., in press). It is to be noted from Table 2 that ovaries of tobacco contain more tryptophane than those of lily. It remains to determine whether the difference is appreciably larger, for in these preliminary experiments it is scarcely large enough to provide a simple explanation of Muir's findings.

TABLE 1

Auxin production by pollen and ovary breis of Lilium regale incubated with tryptophane

Fresh pollen was ground with buffer in a homogenizer; the other tissues had been lyophilized. Incubation 4 hours at 25°C. in 2 ml. of K phosphate buffer, M/50, pH 6.5. Extraction of auxin made with peroxide-free ether after acidification of brei to pH 3.0. The L-tryptophane was purified from traces of indole-3-acetic acid (IAA) by several washings with absolute ethanol and ether.

MATERIAL AND TREATMENT	AMOUNTS OF L-TRYPTOPHANE USED (mg.)	AUXIN IN MICROGRAMS × 10^{-3} IAA PER 10 MG. TISSUE (dry wt.)
Pollen	0.0	0.0
	0.5	10.5
	0.5	22.3
Unpollinated ovaries	0.0	0.0
	0.5	9.2
Unpollinated styles	0.0	0.0
	0.5	20.4
Ovaries, 6 days after pollination	0.0	0.0
	0.5	18.9
Unpollinated ovaries + pollen	0.0	0.0
" " + "	0.5	12.5
" " + " + unpollinated styles	0.0	0.0
L-tryptophane in buffer, pH 6.5	0.5	0.0

The possibility of either a liberation of auxin from an inactive form or of its synthesis through an enzymatic reaction are not the only alternatives by which we can explain the sudden appearance of free auxin in the ovary. The apparent drop in the auxin concentration in the flower at the time of anthesis may not only be explained by the exhaustion of an auxin-producing mechanism,

but also by a more rapid rate of destruction or by the release of an inhibitor at that time. The pollen, then, could merely counteract this inhibition. Looking for an experiment which could demonstrate the existence of such an inhibition mechanism, the reviewer, in a variety of English forcing-cucumber (Sutton's Satisfaction) which produces naturally parthenocarpic and normal female flowers at ordinary temperatures, noticed that the petals of the parthenocarpic flowers generally failed to develop completely. Instead of turning yellow and of opening as they do normally, the petals of most of the parthenocarpic flowers remained small and weakly colored, failing to open

TABLE 2

Free l-tryptophane content of pollen and ovary samples (preliminary data)

Determinations were made using the *Lactobacillus arabinosus* assay (see Nitsch, 1951b).

MATERIAL	FREE L-TRYPTOPHANE (Micrograms)	
	Per 100 mg. d y wt.	per flower
Cucurbita pepo, var. Acorn squash,		
pollen	5.1	0.28
ovaries (not pollinated)	4.0	16.8
Nicotiana tabacum, var. Cuba White		
pollen (from many flowers)	3.0	?
ovaries (not pollinated)	18.8	1.47
Lilium regale		
pollen	6.4	0.38
non-pollinated ovaries	3.6	2.0
non-pollinated styles	4.4	1.86
ovaries, 6 days after pollination	8.4	8.23

while the ovaries continued to enlarge. These flowers recall the giant female flowers which are produced in the Acorn squash at low temperatures; in these, the petals remain greenish and small whereas the ovary enlarges (Nitsch, 1950b; Nitsch et al., 1952). If petals inhibit ovary development at the time of full bloom, then removing them should cause a parthenocarpic fruit to develop. Preliminary experiments were devised in which petals, sepals, and styles were cut off while the flower was still in the bud stage. Some parthenocarpic fruits were obtained by this method with the cucumber Sutton's Satisfaction from buds which should have given rise to normal, non-parthenocarpic female flowers; but the results were negative in the case of the Acorn squash. Incubation of lyophilized petals of Acorn squash flowers with indole-3-acetic acid were also tried, but the added auxin was recovered intact after 4 hours at 25°C. in the dark.

In concluding these considerations on the mechanism responsible for the contrast between the auxin content of the ovary before and shortly after pollination, the reviewer feels that none of the experiments so far devised is completely free of criticism; more work is needed along this line. In fact, one may even argue that the *Avena* test is not adequate to determine whether or not pollen contains a fruit-forming hormone, since substances of the indole-acetic acid type which are most active in this test are the least effective in setting fruits (see section IV).

As to the mechanism which contributes the bulk of the auxin detectable in the pollinated ovary, the results so far obtained do not point toward an enormous contribution from the pollen itself. It is, therefore, necessary to look for another source of auxin in the young fruit. Apparently, besides the pollen, there is only one difference between an unpollinated and a pollinated ovary. This difference is that the ovules remain undeveloped in the first case, while in the second they develop into seeds. We will now inquire whether young seeds exert any action on the growth of a fruit and, if the answer is affirmative, whether they perform this effect through the release of auxins.

III. THE EFFECT OF THE SEEDS ON FRUIT DEVELOPMENT

Action of seeds on fruit growth

In the first part of this review we have mentioned that the absence of abscission of the ovary, although not the cause of fruit growth, is certainly a prerequisite of it. Pollination alone is not sufficient to prevent permanently the abscission of the ovary. In fact, Murneek (1933) distinguishes at least three different types of fruit drops in the apple, the first consisting of structurally and functionally abnormal flowers, the second of unpollinated or unfertilized flowers, the third one of fertilized flowers in which embryos abort early. Although the two first waves contain the largest number of flowers, the third, commonly called the "June drop," is more impressive to the farmer because the fruits have then reached a certain size. As early as 1917, Heinicke had shown that

young apples which contain a low percentage of developing seeds were the ones which drop more readily before full development. This is a first indication of a correlation between seed and fruit development.

It has been pointed out repeatedly in the literature that fruits with few or unequally developed seeds are small or misshapen. For example Müller-Thurgau (1898) observed that, in a given variety of grapes, the weight of the flesh increases with increasing seed number. The same type of relationship seems to hold true for the apple (Heinicke, 1917) and for the strawberry (Nitsch, 1950a). It should be emphasized that the size of a fruit is proportional to the number of well developed ovules, not to the total number of seedlike structures. This relationship is illustrated in Table 3. The effect of young seeds on fruit growth is also visible when only few, irregularly distributed seeds develop. In those instances, misshapen fruits are produced, be it in the apple (Heinicke, 1917; Roberts, 1946; Luckwill, 1949; etc.) or in the strawberry (Fig. 6). In this last instance it is obvious that the ovule stimulates the growth of a fleshy tissue immediately around it, as can be judged from the pictures.

TABLE 3

Proportionality between number of developed achenes and fresh weight of the fleshy receptacle in the strawberry var. Marshall

(Data from Nitsch, 1950b)

TOTAL NUMBER OF ACHENES	NUMBER OF FERTILIZED ACHENES	WEIGHT OF THE RECEPTACLES (mg.)	RATIO: FERTILIZED ACHENES/ WEIGHT OF RECEPTACLES
125	13	220	17
126	29	610	21
76	39	590	15
145	92	1,665	18
165	117	2,500	21
173	123	1,720	14
200	127	2,715	21
232	131	2,300	17

To prove the point more decisively, however, it is necessary to go one step further and to show that removal of the seeds stops fruit growth. In such an attempt, Dollfuss (1936) cut open fruits of several species, including *Symphoricarpus* and *Rosa*, removed the seeds, and replaced them by lanolin pastes. Gustafson, however, (private communication, 1948) was unable to repeat these experiments because of the injury inflicted on the plants. Using a more suitable material, Nitsch (1949a 1950a, b) demonstrated that the growth of a strawberry receptacle can be completely stopped by the removal of all the achenes. This is not due to the injury caused to the fruit, because the growth of full-sized fruits can be obtained after the operation if the proper substance is supplied to the receptacle. As shown in Fig. 7, the effect of the ovules is a continuous one since growth of the receptacle is stopped by their removal as late as 21 days after pollination. Late seed removal, however, does not prevent eventual ripening of the fruit. If only part of the achenes are removed in the strawberry, misshapen fruits are obtained just as if they had been irregularly pollinated. In this case, at least, the effect of pollination on fruit growth is essentially exerted through the ovules.

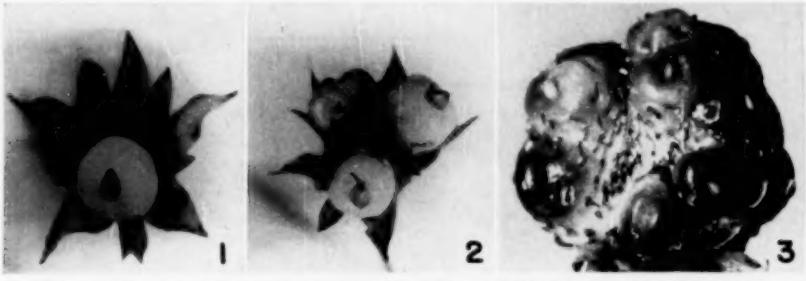

FIG. 6. EFFECT OF THE ACHENES ON THE GROWTH OF THE STRAWBERRY, VAR. MARSHALL

(1), one ovule has been fertilized; (2), three ovules fertilized; (3), several ovules fertilized. The unfertilized ovules have remained small and did not induce growth in the fleshy receptacle. (1 and 2 from Nitsch, 1950a; 3 from Nitsch, 1950b).

The observation concerning the drop of young

fruits, the variation in the shape of a fruit with the position of the developing seeds, the arrest of fruit growth with the removal of the ovules and also the growth of excised ovaries in vitro on media devoid of auxins (the fruit growing only if the ovules have developed to a certain stage after pollination, as shown in the tomato and in *Cucumis anguria* by Nitsch, 1950b, 1951a), all concur to make it clear that developing seeds exert a direct control over fruit growth. The next step is to find out by what mechanisms these seeds stimulate the development of fruits.

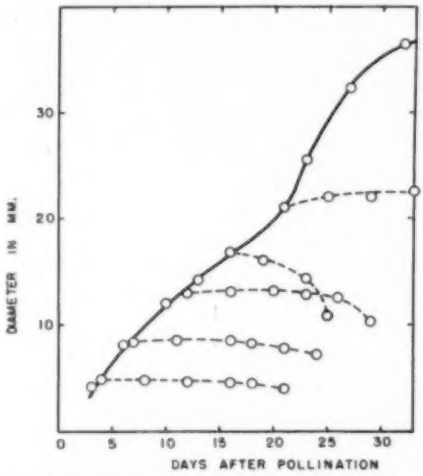

FIG. 7. EFFECT OF COMPLETE REMOVAL OF THE FERTILIZED OVULES ON THE GROWTH OF THE STRAWBERRY, VAR. MARSHALL

Solid line, growth curve of the receptacle of a normal strawberry; dotted lines, growth curves of strawberries which had their achenes removed at different times after pollination. (From Nitsch, 1950b.)

Auxin is the active principle released by the seeds

Gustafson (1939b) extracted various parts of squash and tomato fruits and found that the seeds and the tissues immediately surrounding them were from 6 to 30 times richer in auxin than were other fruit parts. Avery, Berger, and Shalucha (1941) extracted very large quantities of auxin from corn kernels, as did Hatcher (1945) from rye kernels, and Luckwill (1948) from apple seeds. After the suggestion (Nitsch, 1949a) that some substance of a hormonal nature diffuses from the achene to the receptacle of the strawberry to stimulate its growth, actual auxin extractions demonstrated that achenes are rich sources of free auxin, whereas no free auxin could be extracted from the receptacles (Nitsch, 1950a). Thus the physiological action of the seeds upon the growth of the strawberry was reflected in the auxin distribution. In fact, seeds constitute such a good source of auxin that Haagen-Smit et al. (1946) and Redemann, Wittwer, and Sell (1951) used immature corn kernels as a material for extracting large quantities of a natural auxin, the bulk of which was identified as indole-3-acetic acid in the first case (using the *Avena* test as an assay), but as the ethyl ester of this acid in the second case (using the setting of tomato fruits as an assay). Chromatographic procedures led Luckwill (1951, private communication) to conclude that in apple seeds also the active principle is not indoleacetic acid itself. An important indication in favor of the results of Redemann, Wittwer, and Sell and of Luckwill is the well known fact that indoleacetic acid is one of the most unsatisfactory auxins for stimulating fruit growth. This question will be discussed in section IV of this paper. It is important, at this point, to emphasize the importance of care in auxin extraction. As wisely expressed by Went (1951), a sort of race was started some years ago among plant physiologists to squeeze the most auxin out of a plant. The alkaline extraction used by Avery, Berger, and Shalucha (1941), Hatcher (1945), Haagen-Smit, Dandliker, Wittwer, and Murneek (1946), and others leads to definite artifacts because tryptophane is partially converted into indoleacetic acid under such conditions (Gordon and Wildman, 1943; Schocken, 1949). Even the standing of tissues at room temperature is sufficient to lead to the neoformation of auxin (Wildman and Muir, 1949). The concept of "bound-auxin" must be completely revised, if not abandoned, for even incubation with proteolytic enzymes leads to biochemical artifacts (Nitsch et al., in press). Among the most reliable methods is the extraction of lyophilized material with cold ether (0°C.) for a short time, or a diffusion on agar blocks for a short time only (2 hours). Unless such precautions are taken, it is not possible to say whether or not the auxin extracted was really present as auxin in the plant.

If auxin, then, is mostly formed in seeds in contrast to other parts of the fruit, it remains to be seen whether seed extracts, like pollen extracts, are able to set fruits, and whether synthetic auxins are effective also. The first part of the demonstration was provided by the experiments

of Wittwer (1943), Luckwill (1948), and Redemann, Wittwer, and Sell (1951), who set tomato fruits with extracts of corn or apple seeds. That synthetic auxins can set fruits had already been demonstrated by Gustafson (1936) and by many subsequent workers (see the comprehensive review by Gustafson, 1942). Indeed, synthetic auxins can replace the action of the removed ovules in stimulating the growth of strawberries deprived of their achenes (Nitsch, 1949a, 1950a).

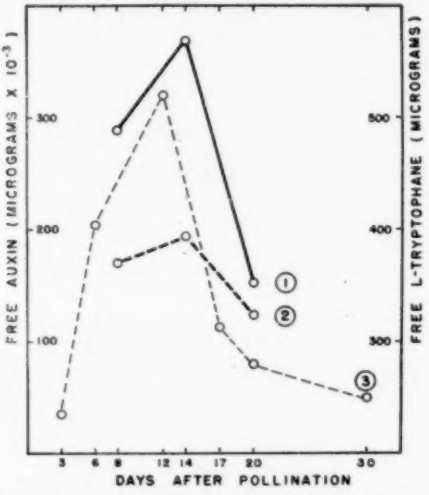

FIG. 8. LEVELS OF "FREE AUXIN" AND "FREE L-TRYPTOPHANE" IN ACHENES OF THE STRAWBERRY (VAR. MARSHALL) AT VARIOUS STAGES OF DEVELOPMENT

Curve 3, from data of Nitsch (1950a). Curve 2, values obtained at Harvard University for auxin on less vigorous plants than in Curve 3. Curve 1, tryptophane levels corresponding to Curve 2. Note that scales are different for auxin and tryptophane.

It can thus be considered as well established that seeds control fruit growth by releasing a chemical stimulus of the auxin type.

The genesis of auxins in seeds

In attempting to find out how this auxin—so important for the growth of the fruit—is manufactured in the seeds, one should first try to localize it in time and space, in other words, should investigate when and where it is produced.

Data for corn (Avery, Berger, and Shalucha, 1942; Wittwer, 1943; Stehsel, 1950), rye (Hatcher, 1945), apple (Luckwill, 1948), strawberry (Nitsch, 1950a), etc., all indicate that the auxin level in the seed is not constant but rises to a peak, to disappear again as the fruit approaches maturity (Figs. 8 and 9). For the reasons stated above, we are considering here only the auxin obtained after a short time of extraction, and not that which can be obtained after digestion of the tissues with NaOH or enzymes. The pattern of auxin liberation in seeds is interestingly similar in monocots and dicots, the peak in auxin production arising in

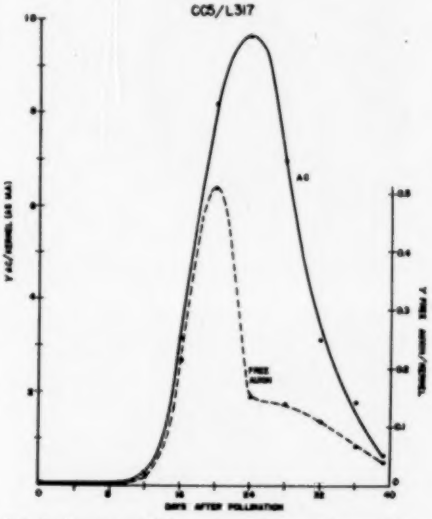

FIG. 9. LEVELS OF "FREE AUXIN" AND "AUXIN-COMPLEX" IN CORN AT VARIOUS STAGES OF DEVELOPMENT

The scales are different for the two substances. (Courtesy Dr. M. Stehsel. From Stehsel, 1950.)

every case a little before midtime between fertilization and the ripening of fruits.

Attempts to localize the center of auxin production in seeds have been made by Avery, Berger, and Shalucha (1941), Hatcher (1945), and Luckwill (1948). Each author found that the concentration of auxin was higher in the endosperm than in any other part of the seed. This is reasonable, since the endosperm is the only tissue, besides the embryo, which arises as a result of fertilization. An extensive comparison between the hormone content and the stage of development of the endosperm allowed Luckwill to correlate the highest concentration of hormone in the seed with the time at which the endosperm becomes cellular.

A glimpse at Figs. 8 and 10, which give similar results for the strawberry, may give an idea of this relationship.

In an attempt to gather more information about this long-neglected field of the physiology of the seed and the embryo, let us bring together three more series of facts about the biochemistry of the developing seed.

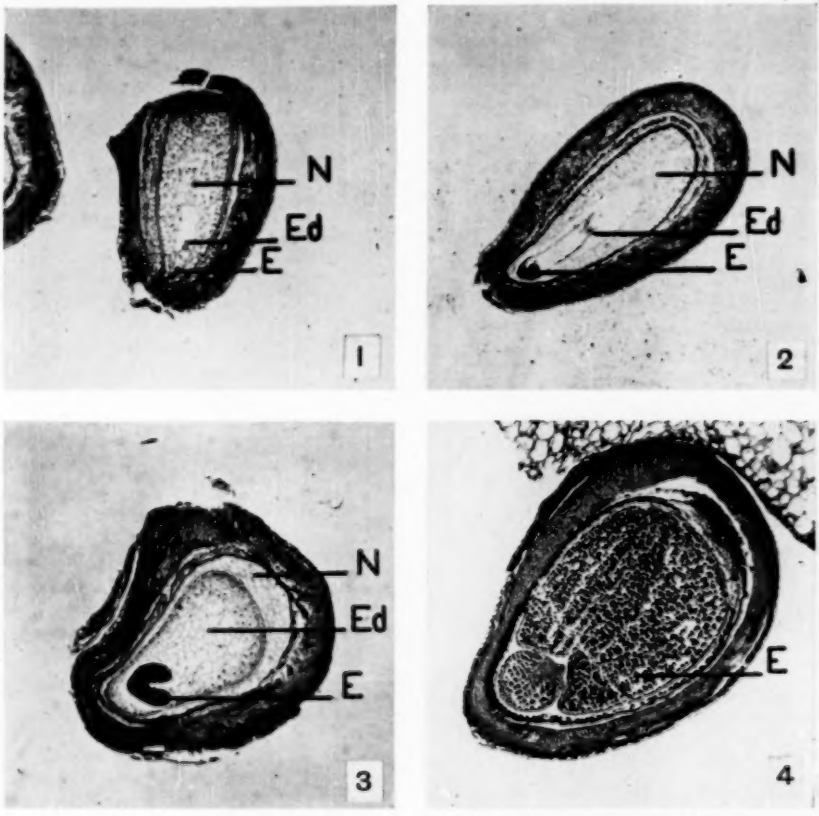

FIG. 10. ANATOMICAL DEVELOPMENT OF THE ACHENE OF THE STRAWBERRY, VAR. MARSHALL
(1), 4 days; (2), 8 days; (3), 12 days; and (4), 20 days after pollination. E, embryo; El, endosperm; N, nucellar tissues. Same magnification (× 36) in each picture.

The first series of facts concerns the tryptophane content of the seed. Stehsel (1950) has followed the variations in tryptophane content of seeds from two different strains of corn. The total tryptophane, as determined after hydrolysis of proteins, increases steadily. Unfortunately, no data are given for the "free," i.e., non-protein-bound tryptophane, which appears to be of much greater significance in our search for a precursor of the auxin in seeds. Recent data on free tryptophane in the strawberry are shown in Fig. 8. It is most striking that the peak of free tryptophane in the seeds coincides with the peak in free auxin, although there is about 3,000 times more tryptophane than auxin. It is interesting to note that an increase in free tryptophane is clearly detectable only a few days after pollination, as shown by the data of Table 2 concerning lily ovaries. In an attempt to correlate the peak in both free auxin and free tryptophane with seed development, one

might observe that not only does it coincide with the moment at which the endosperm becomes cellular but also with a time at which the endosperm is very actively digesting away the nucellar tissues. Since, however, Stehsel's data clearly indicate a constant rise in total tryptophane, it is evident that all the tryptophane involved cannot simply be liberated by protein hydrolysis, but some must actually move into the seed at that time. A most unexpected result was found by Nitsch (1951b) in the fleshy receptacle of the strawberry, where free tryptophane seems to pile up as development proceeds (Table 4). One might then ask: if auxin comes from tryptophane in the seed, what of the receptacle, where no free auxin can be detected? A possible, though highly speculative, answer to this question might be that the low pH in the receptacle might account for such a blocking in the tryptophane to auxin transformation. A low pH seems, at least in vitro, to prevent the natural tendency of tryptophane from being converted into an active auxin.

A second possible precursor of auxin in seeds has been much studied by Stehsel (1950) and is termed by him "auxin complex." This substance is water-soluble but not ether-soluble (Avery, Berger, and Shalucha, 1941), and is inactive in the *Avena* test, but it can be transformed into an active auxin by short boiling at pH 7 to 9. A similar substance seems to be present in the apple endosperm (Luckwill, private communication, 1951). The studies of Stehsel (1950, private communication) show that the molecular weight of the "auxin complex" is about double that of indoleacetic acid, and that upon hydrolysis it gives rise to two molecules, both of which are active in the *Avena* test and give a red color with the Salkowski reagent, but which, upon paper chromatography, form two separate spots.

A third series of facts pertaining to the development of the ovules concerns the "coconut milk factor" which was first discovered and studied by van Overbeek, Conklin, and Blakeslee (1941). Looking for a nutrient suitable for growing very young embryos in vitro, these workers found that the milk of a coconut—which represents a liquid endosperm—indeed contains a very potent growth factor apparently different from the usual auxins. From the recent and comprehensive studies of Steward and his coworkers a new fact emerges, namely, that the "coconut milk factor" is present also in the endosperm of other seeds, especially in corn and gingko. Perhaps this explains why Blakeslee and Satina (1944) found that *Datura* embryos respond to malt almost as well as to coconut milk. It is most interesting to note that the extracts from corn ovules have been found by Steward and Caplin (1952, in press) to be most active about two weeks after pollination (Fig. 11), a time which seems to coincide with the rise in the concentration of both free auxin and "auxin complex." Neither pollen nor unpollinated ovule extracts showed any "coconut milk factor" activity.

TABLE 4

Non-protein-bound L-*tryptophane in the strawberry var. Marshall*

(Data from Nitsch, 1951b)

DAYS AFTER POLLINATION	L-TRYPTOPHANE (micrograms per 100 mg. dry wt.)		L-TRYPTOPHANE (micrograms per strawberry)		pH OF TISSUE BREIS	
	Achenes	Receptacle	Achenes	Receptacle	Achenes	Receptacles
8	4.88	6.48	1.30	1.70	5.3	4.4
14	5.68	10.56	3.13	8.57	5.8	3.8
20	3.52	22.40	3.89	53.98	5.8	3.5

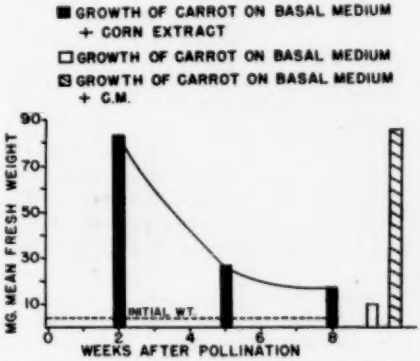

FIG. 11. CONCENTRATION OF COCONUT FACTOR IN CORN KERNELS AT THREE STAGES OF DEVELOPMENT, AS TESTED BY THE PLANT TISSUE CULTURE TECHNIQUE

(Courtesy Prof. F. C. Steward and Dr. S. M. Caplin, 1951.)

In conclusion, one should expect that the investigations in different laboratories will bring out interesting discoveries. As to the effect of coconut milk itself on fruit growth, the writer did not find that it stimulates ovary growth more than auxins. Coconut milk would thus constitute a growth factor for the seeds rather than for the fruit itself.

Fruit maturation

The physiology of ripening has been recently reviewed by Biale (1950). It will only be pointed out here that seeds may exert an effect upon fruit maturation. Softening and browning of pears, for example, can often be observed to start around the core. A study by Wardlaw and Leonard (1936) has illustrated this effect of seeds in the papaw. Ripening color occurs first in the fleshy stalks on which individual seeds are borne, then follows the vascular strands, and spreads throughout the entire fruit.

Auxins also have been shown to behave as ripening agents. For example, 2,4-D can be used to ripen green bananas, apples, and pears (Mitchell and Marth, 1944). Blondeau and Crane (1950) have shown that 2,4;5-T (2,4,5-trichlorophenoxyacetic acid) sprays very much hasten the ripening of the Calimyrna fig. It is then not improbable that seeds not only control fruit growth but regulate also—to some extent—fruit ripening.

IV. PARTHENOCARPY

Definitions

The term "parthenocarpy" was introduced by Noll (1902) to designate fruit formation without pollination or other stimulation. Winkler (1908) defined parthenocarpy as the production of fruits without seeds or with empty seeds. Today, parthenocarpy is generally considered as the *formation of a fruit without fertilization of the ovules*, a definition parallel to that of parthenogenesis, which is the formation of an embryo without fertilization.

Parthenocarpy may result from many different causes which have not always been well distinguished in the past literature. First, it is important to know if pollination has occurred or not. Pollen incapable of germination may stimulate fruit formation (Yasuda, 1934b); pollen may germinate but the pollen tubes may never reach the ovary, so as to result in the formation of seedless fruits (Yasuda, 1934b, 1939). If such cases of fruit development may still be called parthenocarpic, this qualification cannot be given to cases in which seedlessness results from early abortion of the embryos. In other words, seedless fruits should not be automatically considered as parthenocarpic. Nevertheless, if we maintain the term "fertilization" as the critical word in the definition of parthenocarpy, rather than "pollination," then we must distinguish, as Winkler (1908) has pointed out, between parthenocarpy which is "stimulative", i.e., caused by the stimulus of pollination, and that which is "vegetative", i.e., occurs without any pollination.

This distinction remains when one tries to classify the various known cases of parthenocarpy according to the conditions which originated it. Parthenocarpy may be of genetical, environmental, or chemical origin.

Genitical parthenocarpy

The Valencia and Hamlin varieties of oranges (*Citrus sinensis* Osbeck) have been reported by Wong (1939) to produce fruits even though they had not been pollinated. Webber (1930) cited by Gustafson (1942), performed experiments on the Navel orange. He emasculated a series of flowers before the pollen or the pistil had matured and protected the flowers from cross-pollination with paper bags. He obtained perfectly normal, but seedless, fruits. In cucurbits, several varieties of forcing-cucumbers produce parthenocarpic fruits without pollination (Wellington and Hawthorn, 1929). The oriental persimmon (*Diospyros kaki*), as well as some varieties of figs, pears, and grapes, is often parthenocarpic. The cultivated banana is always parthenocarpic (D'Angremond, 1912), while the wild banana is not. According to Dodds and Simmonds (1948), a single gene accounts for the parthenocarpic behavior of some banana strains. In addition, a number of modifiers influence the extent of parthenocarpic development.

That such natural parthenocarpy is determined by a high content of auxin has been shown by Gustafson (1939a), who found that flower buds of seedless oranges, lemons, and grapes contain more auxin than flower buds of comparable seeded varieties. This stimulation of auxin production in some varieties of flower buds is probably due to the genetic constitution. The plants that are naturally parthenocarpic, such as oranges and grapes, may have a gene that is responsible for either increased auxin production or increased auxin inactivation. Indeed, Lesley and Lesley (1941) obtained a tomato plant which was deficient for about one-third of a chromosome. This plant and its aneuploid derivatives were very fruitful and produced parthenocarpic fruits when pollination was prevented.

Environmental parthenocarpy

Scattered reports in the literature indicate that unusual weather conditions may induce the forma-

tion of parthenocarpic fruits in plants which usually produce seeded fruits. For example, Campbell (1912), cited by Gustafson (1942), reports that a heavy fog in June caused the formation of seedless olives. Höstermann (1913) observed that after a frost seedless fruits were produced in the pear Lebrun's Butterbirne. Lewis (1942) obtained parthenocarpic pears by exposing the flowers to freezing temperatures in a refrigerator from 3 to 19 hours. In egg-plant and tobacco, Yasuda (1939) observed that, when the temperature became lower and as the plants grew older autumn, parthenocarpic fruits were produced. In pepper (*Capsicum frutescens*), Cochran (1936) increased fruit setting and obtained many parthenocarpic fruits by shifting the plants at the time of anthesis from temperatures of 32–38°C. and 21–27°C. to 10–16°C. Höstermann (cited by Gustafson, 1942) found that as the season advanced parthenocarpic fruits were produced by tomatoes. This result has been obtained experimentally by Went (1952) by subjecting tomatoes of the Essex Wonder variety to low night temperatures (6–10°C). In such experiments, however, it is not always possible to ascertain that pollination without fertilization has not taken place. Smith and Cochran (1935) found that at 10°C. pollen germination and tube growth is very slow in the tomato, so that the pollen tubes may never reach the ovules. Some of the reported cases of parthenocarpy through cold treatments may, therefore, be actually due to the auxin brought by the pollen, and thus enter the category of stimulative parthenocarpy

Rare are the experiments in which pollination has been clearly prevented. Höstermann (cited by Gustafson, 1942) prevented pumpkin ovaries from being pollinated. As the season advanced the ovaries developed more and more before they dropped off, and finally in October and November produced several parthenocarpic fruits. Recent experiments from which the pollination factor has been rigorously excluded have been contributed by Nitsch et al. (1952) for *Cucurbita pepo* and *Cucumis sativus*, and by Osborne (1952) for the tomato. In both cases, low temperatures definitely acted as stimulants for fruit set. Sufficient light is also necessary, for natural parthenocarpy was obtained by Osborne only if either the intensity or the length of illumination was above a certain threshold. It is of interest that inhibition of flower abscission due to climatic conditions varied in the same direction as parthenocarpic stimulation.

In summary, environmental factors, especially low temperatures and high light intensity, favor the production of parthenocarpic fruits either directly, indirectly (i.e., by preventing fertilization), or both.

Parthenocarpy induced by applied auxins

Since Gustafson (1936) first obtained parthenocarpic fruits by artificial applications of synthetic auxins, the development of this branch of the auxin field has expanded enormously. A detailed account of the techniques involved has been given by Gustafson (1942), Avery et al. (1947), Mitchell and Marth (1947), and others. We will discuss here only certain points concerning the physiology of this chemical fruit-setting.

FIG. 12. INDUCTION OF PARTHENOCARPIC TOMATOES BY SMEARING A LANOLIN PASTE CONTAINING 3.3 p.p.m. of 2,4-D ON THE PEDUNCLE OF THE FLOWER CLUSTER AT A CERTAIN DISTANCE FROM THE FLOWERS
(From Nitsch, 1950b.)

In order to induce fruit set, auxins may be applied in lanolin pastes, in liquid sprays, or in vapor form. Synthetic auxins do not need to be applied on the style or the ovary itself; they are also effective when supplied to the flower stalk (Fig. 12) or even to the soil (Hoffmann and Smith, 1949).

In general, the type of chemical effective as a fruit-setting auxin is the same as for promoting cell elongation, root formation, etc. In other words, to be active, a compound must have: (1)

a ring, (2) unsaturation in this ring, (3) an acidic group, (4) a distance of at least one carbon atom between the acidic group and the ring, and (5) a particular spatial relationship between the carboxyl group and the ring. Since the five conditions for activity were first laid down by Koepfli, Thimann, and Went (1938), this spatial relationship has been defined by Veldstra (1944a, b) as being a condition of perpendicularity of the side chain with the plane of the ring. Osborne and Wain (1951a) have recently laid emphasis on the importance of a free hydrogen atom on the alpha carbon of the side-chain. Substitution in this carbon atom removes the activity, as was first shown by Koepfli, Thimann, and Went (1938). A large number of substances effective in inducing parthenocarpy in the tomato have been listed by Zimmerman and Hitchcock (1944). N-aryl-phthalamic acids have been added to the list of active compounds by Hoffmann and Smith (1949). New studies concerning the relationships between chemical constitution and parthenocarpic activity have been published by Osborne, Wain and Walker (1952).

One of the most puzzling facts is that indole-3-acetic acid, most active in the *Avena* test, has very little activity in inducing parthenocarpy. To account for such a discrepancy, one might make several suggestions: (1) perhaps indole-3-acetic acid is rapidly destroyed in the conditions of application (long exposure to bright sunlight, etc.), but the use of fruit culture in vitro (Nitsch) shows that even there indole-3-acetic acid is almost ineffective in setting fruits; (2) perhaps indole-3-acetic acid is rapidly destroyed by plant enzymes similar to those described by Tang and Bonner (1947) and by Wagenknecht and Burris (1950); or (3) perhaps the native fruit-setting hormone is not indoleacetic acid.

To solve such problems much more work is needed.

Another important point is to make clear that to date not all fruits have been successfully set with applied auxins. Among the most outstanding exceptions emerge the stone fruits (cherries, plums, peaches, etc.). Wann (1950) has recorded such unsuccessful experiments with cherries, and the writer (unpublished) has had the same experience with cherries, plums, and peaches. Despite isolated reports (Sereiskij, 1938), no real success had been achieved with pome fruits either (Gardner and Marth, 1937; Gardner, Marth, and Batjer, 1939) until recently Osborne and Wain (1951b) obtained good setting of parthenocarpic pears and apples by using repeated spraying of α-(2-naphthoxy)-propionic acid in the first instance and of α-phenoxypropionic acid (D form) in the second. Fruits with many ovules, on the contrary, are generally relatively easy to set with applied auxins: tomato, egg-plant, pepper, tobacco, squash, rose, strawberry, fig, etc.

The role of ovules in parthenocarpy

The fact, just mentioned, of this discrepancy between the effectiveness of auxins in setting one-seeded vs. many-seeded fruits is worth noticing. In addition, one single auxin application at the time of flower opening is often sufficient to stimulate the development of a tomato ovary to a full-sized fruit. Such a long-lasting effect can hardly be explained exclusively by a direct action of the applied auxin. The author would suggest that one of the effects of a direct application of auxin may be to stimulate ovule development, which, in turn, promotes fruit growth. Such an explanation is based on two sets of facts.

Firstly, fruits developing parthenocarpically in nature are not seedless at the time the ovary development is definitely set into motion. In the cucumber variety Sutton's Satisfaction, the parthenocarpic fruits produced naturally contain seedlike structures, some of which have reached the size of a normal seed, with fully developed seed coats, but lacking embryos or endosperms. The seed cavity is completely filled with nucellar tissue (Fig. 13).

Secondly, the application of auxins indeed stimulates the growth of the ovules. This can be deduced from the observation that ovules differentiate in orchids only as a result of pollination (Crüger, 1851). The most decisive argument, however, is the fact that applied auxin directly stimulates ovule development in holly (Gardner and Kraus, 1937), *Citrullus vulgaris*, and *Cucurbita pepo* (Wong, 1941), *Melandrium* (van Overbeek, Conklin, and Blakeslee, 1941), etc. Indeed, if auxins are applied to fruits that are naturally seedless, seedlike structures develop as in oranges (Stewart and Klotz, 1947) and in grapes (Weaver and Williams, 1950). In tomatoes, development of a gelatinous material in the placental region is stimulated by the application of auxins. In most cases, when such seedlike structures are examined at the time the fruit is ripe, they are found to consist of well developed seed coats with an empty space in the middle. If the suggestion that

unpollinated ovules may stimulate fruit development is correct, then it cannot be made a general rule that endosperm is absolutely indispensable in all cases.

V. EFFECTS OF AUXIN ON SOME PHYSIOLOGICAL MECHANISMS INVOLVED IN FRUIT GROWTH

Prevention of abscission

That auxins are effective in delaying or preventing abscission of debladed leaves is known since the work of Laibach (1933b) and La Rue (1935) on *Coleus*. Similar results can be obtained in the case of needles of evergreens (Dostal, 1943; Thimann, 1948). In the case of fruits, auxins seem to promote two opposite effects, i.e., they prevent abscission of nearly ripe fruits, but they increase abscission of young fruits (see, for example, Gardner, 1951). In fact, chemical fruit-thinning with auxins has become almost as much used by the fruit growers as the use of the same auxins to delay preharvest drop (see Batjer and Hoffmann, 1951). To account for such an apparent contradiction, one must consider two facts. Firstly, the anatomical changes associated with abscission differ from one type to the other, early drop of young fruitlets being associated with the formation of an abscission layer through cell division, preharvest drop with weakening of the cell walls in the same zone (MacDaniels, 1937; McCown, 1938). Secondly, the first effect of an auxin spray on young fruitlets is indeed to prevent abscission, keeping on the plant more fruits than it can properly nourish, which results in rapid exhaustion of metabolites necessary for fruit growth. A nutritional drop follows. This fact leads us to investigate briefly the role of auxin in the mechanism of fruit nutrition.

Water uptake

Fruits are conspicuously rich in water. In 1917, Heinicke had shown that seeds in the apple are important in its water metabolism. By letting young apples dry in the laboratory, he observed that shrivelling of the fruits occurred in the region where no seeds had developed. Since the studies of Reinders (1938) it has been known that auxins promote water uptake in plant tissues. This effect has been shown to be mediated through the general respiratory metabolism (see Kelly, 1947; Hackett, 1951). It is very probable that one of the effects of the auxin produced by the pollen and the seeds is to regulate an *active* water uptake by the

FIG. 13. SECTION OF THE LOWER PORTION OF ONE OF THE SEEDLIKE STRUCTURES FOUND IN RIPE ENGLISH FORCING-CUCUMBERS, VAR. SUTTON'S SATISFACTION, WHICH DEVELOPED PARTHENOCARPICALLY WITHOUT APPLICATION OF AUXINS

The section shows the micropylar end but is not quite median. N, nucellar tissue. Magnified 28 times.

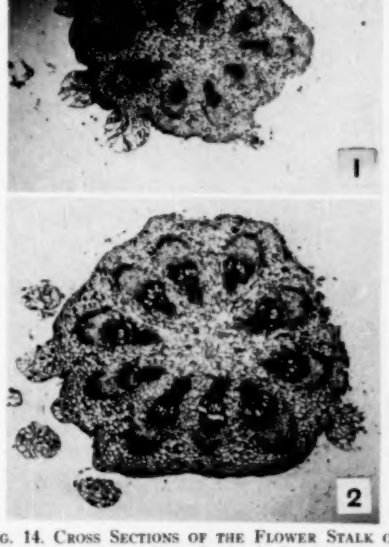

FIG. 14. CROSS SECTIONS OF THE FLOWER STALK OF CUCUMIS SATIVUS, VAR. SUTTON'S SATISFACTION

(1), at the time of pollination; (2), 14 days after pollination. Note contrasting development of the vascular bundles. Same magnification in both cases (about × 7).

fruit. In fact, Hsiang (1951) has shown that, within 30 minutes, cut discs of columns from pollinated orchid flowers take up significantly more water than discs from unpollinated orchids. Oxygen is also necessary for this active water uptake.

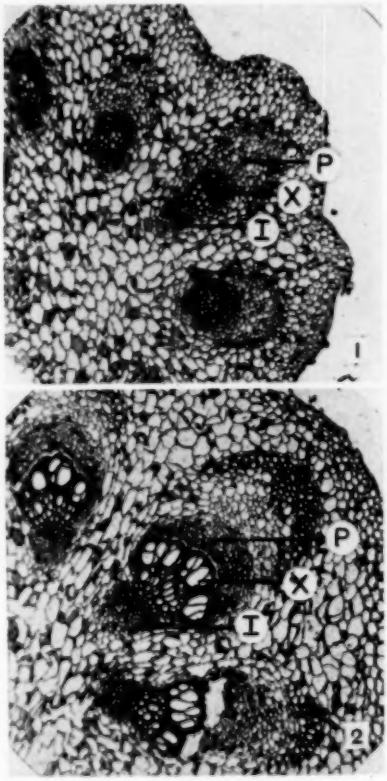

FIG. 15. DETAIL OF A VASCULAR BUNDLE OF THE SECTIONS SHOWN IN FIG. 14

(1), at the time of pollination; (2), 14 days after pollination. Same magnification in both cases (about × 28). P, phloem; X, xylem; I, internal phloem.

Initiation of vascular development

In connection with the ability to attract large amounts of water, the seeds seem also to promote vascular development. In crucifers, the vascular tissue of the flower ends blindly and does not connect with the stem until a young fruit is set (Eames, private communication, 1951). Figs. 14 and 15 show how important is the increase in vascularization of the flower stalk of *Cucumis sativus*, two weeks after pollination. This development becomes dramatic in the case of *Cucurbita maxima*, as shown in Fig. 16. In this case we have observed, like others before, that the set of one fruit has the immediate effect of inhibiting shoot development, a fact which has been explained in the past as the result of an active competition for metabolites. In this competition, the fertilized ovules are certainly developing whereas the stem meristem is not, perhaps also through a typical auxin inhibition.

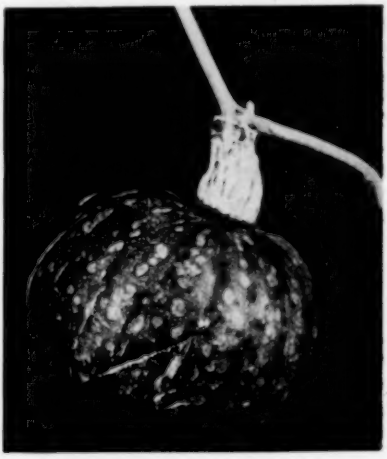

FIG. 16. DEVELOPMENT OF THE FRUIT STALK IN CUCURBITA MAXIMA

Note the enormous increase in diameter of the fruit stalk in comparison to the stem, which has kept its initial diameter, possibly because its structure was fixed long before the fruit started developing.

That auxins can be responsible for vascular differentiation (at least of the xylem) has been shown by various techniques, especially in tissue culture by Camus (1949), and by regeneration studies of interrupted vascular bundles by Jacobs (1952). The latter author could establish a proportionality between the amount of auxin applied and the number of regenerated vascular strands.

Here we terminate these brief indications as to some of the physiological mechanisms involved in fruit growth which have been shown to be directly influenced by auxins. The biochemical mechanism whereby auxins bring about growth is still not clear, although active work to investigate it is being carried out in many laboratories. There is no doubt that any major discovery regarding

the mechanism of auxin action will also shed new light on the physiology of fruit growth.

CONCLUSION

In starting this review, we attempted to define a fruit through its relationship to the ovules. All along in our survey, we have found that ovules are indeed very important in controlling the development of those tissues—the ovary, receptacle, etc.—which will accumulate water, sugars, vitamins, and other substances and become the structures we call fruits. Throughout the life of a fruit, auxins play a primary role, as they seem to do in almost every aspect of plant growth.

ACKNOWLEDGMENTS

The author is indebted to Prof. F. C. Steward and Drs. Luckwill, Osborne, Caplin, and Stehsel for sending him manuscripts of papers in advance of publication; to Profs. R. H. Wetmore and K. V. Thimann for their kind help in the preparation of this manuscript; to Miss Jane Richards for invaluable assistance in many phases of the unpublished work presented here; to Miss Mary Perrine for aid in the preparation of the illustrations; to the firm of Sutton and Sons, England, for supplying cucumber seeds; and to the Direction of *Relations Culturelles*, Paris, France, for the initial scholarship which allowed him to come to the United States where most of the research cited in this paper was done.

LIST OF LITERATURE

ALLEN, C. E. 1940. The genotypic basis of sex-expression in angiosperms. *Bot. Rev.*, 6: 227–300.

AVERY, G. S., JR., ET AL. 1947. *Hormones and Horticulture.* McGraw-Hill, New York.

——, J. BERGER, and B. SHALUCHA. 1941. The total extraction of free auxin and auxin precursor from plant tissue. *Amer. J. Bot.*, 28: 596–607.

——, ——, and ——. 1942. Auxin content of maize kernels during ontogeny, from plants of varying heterotic vigor. *Amer. J. Bot.*, 29: 765–772.

BATJER, L. P., and M. B. HOFFMAN. 1951. Fruit thinning with chemical sprays. *U. S. Dept. Agric. Circ.*, 867: 1–46.

BAYLISS, W. M., and E. STARLING. 1904. The chemical regulation of the secretory process. *Proc. Roy. Soc.*, B, 73: 310–322.

BIALE, T. B. 1950. Postharvest physiology and biochemistry of fruits. *Ann. Rev. Plant Physiol.*, 1: 183–206.

BLAKESLEE, A. F., and S. SATINA. 1944. New hybrids from incompatible crosses in *Datura* through culture of excised embryos on malt media. *Science*, 99: 331–334.

BLONDEAU, R., and J. C. CRANE. 1950. Further studies on the chemical induction of parthenocarpy in the calimyrna fig. *Plant Physiol.*, 25: 158–168.

BONNER, J., and H. BONNER. 1948. The B vitamins as plant hormones. *Vitamins and Hormones*, 6: 225–275. Acad. Press, New York.

BONNER, J., and J. THURLOW. 1949. Inhibition of photoperiodic induction in *Xanthium* by applied auxin. *Bot. Gaz.*, 110: 613–624.

BRESLAVETZ, L. 1936. Investigation of the development of hemp flowers with regard to change in sex under the influence of photoperiodism. *Bull. Soc. nat. Moscow*, 44: 182–189.

BUCHENAU, F. 1903. Entwickelung von Staubblättern im Innern von Fruchtknoten bei *Melandryum rubrum* Garcke. *Ber. dtsch. bot. Ges.*, 21: 417–424.

CAMPBELL, C. 1912. Un caso di partenocarpia nell' olivio? *Nuovo G. bot. ital.*, 19: 86–89.

CAMUS, G. 1949. Recherches sur le role des bourgeons dans les phénomènes de morphogénèse. *Rev. Cytol. Biol. veg.*, 11: 1–199.

COCHRAN, H. L. 1936. Some factors influencing growth and fruit setting in pepper. (*Capsicum frutescens* L.) *Cornell Univ. agric. exp. Sta. Mem.*, 190: 1–39.

CORRENS, C. 1907. *Die Bestimmung und Vererbung des Geschlechtes, nach neuen Versuchen mit höheren Pflanzen.* Berlin.

——. 1928. Bestimmung, Vererbung und Verteilung des Geschlechtes bei den höheren Pflanzen. *Hb. Vererb.*, 2C: 1–138.

CRÜGER, H. 1851. Ueber Befruchtung bei den Orangen. *Bot. Z.*, 9: 57–63, 73–80.

D'ANGREMOND, A. 1912. Parthenokarpie und Samenbildung bei Bananen. *Ber. dtsch. bot. Ges.*, 30: 686–691.

DODDS, K. S., and N. W. SIMMONDS. 1948. Sterility and parthenocarpy in diploid hybrids of *Musa*. *Heredity*, 2: 101–117.

DOLLFUSS, H. 1936. Wuchsstoffstudien. *Planta*, 25: 1–21.

DOSTAL, R. 1943. Zur experimentellen Erzeugung der Trennungsschicht an den Taxus-Nadeln. *Planta*, 33: 558–575.

DUNCAN, R. E., and J. T. CURTIS. 1942a. Intermittent growth of fruits of *Phalaenopsis*. A correlation of the growth phases of an orchid fruit with internal development. *Bull. Torrey bot. Club*, 69: 167–183.

——, ——. 1942b. Intermittent growth of fruits of Cypripedium and Paphiopedilum. A correlation of the growth of orchid fruits with their internal development. *Bull. Torrey bot. Club*, 69: 353–359.

EDMOND, J. B. 1930. Seasonal variation in sex expression of certain cucumber varieties. *Proc. amer. Soc. hort. Sci.*, 27: 329–332.

FITTING, H. 1909. Die Beeinflüssung der Orchideenblüten durch die Bestäubung und durch andere Umstände. *Z. Bot.*, 1: 1–86.

GARDNER, F. E. 1951. Growth substances in relation to the production of tree fruits. In *Plant Growth Substances*, (F. Skoog, ed.) pp. 207–223. Univ. of Wisconsin Press, Madison.

——, and E. J. KRAUS. 1937. Histological comparison of fruits developing parthenocarpically and following pollination. *Bot. Gaz.*, 99: 355–376.

——, and P. C. MARTH. 1937. Parthenocarpic fruits induced by spraying with growth-promoting compounds. *Bot. Gaz.*, 99: 184–195.

——, ——, and L. P. BATJER. 1939. Spraying with plant growth substances for control of the preharvest drop of apples. *Proc. amer. Soc. hort. Sci.*, 37: 415–428.

GARDNER, V. R. 1923. Studies in the nutrition of the strawberry. *Missouri agric. exp. Sta. Res. Bull.*, 57: 1–31.

GORDON, S. A., and S. WILDMAN. 1943. The conversion of tryptophane to a plant growth substance by conditions of mild alkalinity. *J. biol. Chem.*, 147: 389–398.

GUSTAFSON, F. G. 1936. Inducement of fruit development by growth promoting chemicals. *Proc. natl. Acad. Sci. USA*, 22: 628–636.

——. 1937. Parthenocarpy induced by pollen extracts. *Amer. J. Bot.*, 24: 102–107.

——. 1939a. The cause of natural parthenocarpy. *Amer. J. Bot.*, 26: 135–138.

——. 1939b. Auxin distribution in fruits and its significance in fruit development. *Amer. J. Bot.*, 26: 189–194.

——. 1942. Parthenocarpy: natural and artificial. *Bot. Rev.*, 8: 599–654.

HAAGEN-SMIT, A. J., W. B. DANDLIKER, S. H. WITTWER, and A. E. MURNEEK. 1946. Isolation of 3-indole acetic acid from immature corn kernels. *Amer. J. Bot.*, 33: 118–120.

HACKETT, D. P. 1951. The uptake of water by storage tissue, with special reference to the effect of auxin. Thesis. Harvard University. 152 pp.

HATCHER, E. S. J. 1945. Studies in the vernalisation of cereals. IX. Auxin production during development and ripening of the anther and carpel of spring and winter rye. *Ann. Bot.*, 9 N. S.: 235–266.

HEINICKE, A. J. 1917. Factors influencing the abscission of flowers and partially developed fruits of the apple (*Pyrus malus* L.). *Cornell Univ. agric. exp. Sta. Bull.*, 393: 1–114.

HOFFMANN, O. L., and A. E. SMITH. 1949. A new group of plant growth regulators. *Science*, 109: 588.

HÖSTERMANN, G. 1913. Berichte über die Tätigkeit der wissenschaftlichen Institute. I. Pflanzenphysiologische Versuchsstation. *Ber. kgl. Gartenl., Dahlem*, 1913: 54–62.

HOUGHTALING, H. B. 1935. A developmental analysis of size and shape in tomato fruits. *Bull. Torrey bot. Club*, 62: 243–252.

HOWLETT, F. S. 1936. The effect of carbohydrate and nitrogen deficiency upon microsporogenesis and the development of the male gametophyte in the tomato, *Lycopersicum esculentum* Mill. *Ann. Bot.*, 50: 767–803.

——. 1939. The modification of flower structure by environment in varieties of *Lycopersicum esculentum*. *J. agric. Res.*, 58: 79–117.

HSIANG, T. T. 1951. Physiological and biochemical changes accompanying pollination in orchid flowers. I. General observations and water relations. *Plant Physiol.*, 26: 441–455.

JACOBS, W. P. 1952. (In press).

JONES, K. L. 1947. Studies on *Ambrosia*. IV. Effects of short photoperiod and temperature on sex expression. *Amer. J. Bot.*, 34: 371–377.

KATUNSKIJ, V. M. 1936. On the causes of pre- and post-floral movements of peduncles and scapes (of the genera *Papaver*, *Crepis* and *Tussilago*). *C. R. (Doklady) Acad. Sci. USSR*, 12: 343–346.

KELLY, S. 1947. The relationship between respiration and water uptake in the oat coleoptile. *Amer. J. Bot.*, 34: 521–526.

KENDALL, J. N. 1918. Abscission of flowers and fruits in the *Solanaceae* with special reference to *Nicotiana*. *Univ. Calif. Pub. Bot.*, 5: 347–428.

KOEPFLI, J. B., K. V. THIMANN, and F. W. WENT. 1938. Phytohormones: structure and physiological activity. I. *J. Biol. Chem.*, 122: 763–780.

KÖGL, F., and A. J. HAAGEN-SMIT. 1931. Über die Chemie des Wuchsstoffs. *Proc. kgl. Akad. Wetensch., Amsterdam*, 34: 1411–1416.

——, A. J. HAAGEN-SMIT, and H. ERXLEBEN. 1934. Über ein neues Auxin ("Heteroauxin") aus Harn. XI. Mitteilung. *Z. physiol. Chem.*, 228: 90–103.

LAIBACH, F. 1932. Pollenhormon und Wuchsstoff. *Ber. dtsch. bot. Ges.*, 50: 383–390.

——. 1933a. Wuchsstoffversuche mit lebenden Orchideenpollinien. *Ber. dtsch. bot. Ges.*, 51: 336–340.

——. 1933b. Versuche mit Wuchsstoffpaste. *Ber. dtsch. bot. Ges.*, 51: 386–392.

——, and F. J. KRIBBEN. 1949. Der Einfluss von Wuchsstoff auf die Bildung männlicher und weiblicher Blüten bei einer monözischen Pflanze (*Cucumis sativus* L.). *Ber. dtsch. bot. Ges.*, 62: 53–55.

——, and ——. 1950a. Der Einfluss von Wuchsstoff auf das Geschlecht der Blüten bei einer monözischen Pflanze. *Beitr. Biol. Pflanz.* 28: 64–67.

——, and ——. 1950b. Der Einfluss von Wuchsstoff auf die Blütenbildung der Gurke. *Naturwiss.*, 37: 114–115.

——, and ——. 1950c. Über die Bedeutung der B-Indolylessigsäure fur die Blütenbildung. *Ber. dtsch. bot. Ges.*, 63: 119–120.

——, and ——. 1950d. Die Bedeutung des Wuchsstoffs für die Bildung und Geschlechts-bestimmung der Blüten. *Beitr. Biol. Pflanz.*, 28: 131–144.

——, and E. MASCHMANN. 1933. Über den Wuchsstoff der Orchideenpollinien. *Jb. wiss. Bot.*, 78: 399–430.

LARSEN, P., and S. M. TUNG. 1950. Growth-promoting and growth-retarding substances in pollen from diploid and triploid apple varieties. *Bot. Gaz.*, 111: 436–447.

LARUE, C. D. 1935. The role of auxin in the development of intumescences on poplar leaves; in the production of cell outgrowths in the tunnels of leaf miners; and in the leaf-fall in *Coleus*. *Amer. J. Bot.*, 22: 908. (Abst.)

LEOPOLD, A. C. 1951. Photoperiodism in plants. *Quart. Rev. Biol.*, 26: 247–263.

LESLEY, M. M., and J. W. LESLEY. 1941. Parthenocarpy in a tomato deficient for a part of a chromosome in its aneuploid prophase. *Genetics*, 26: 374–386.

LEWIS, D. 1942. Parthenocarpy induced by frost in pears. *J. Pomol. Hort. Sci.*, 20: 40–41.

LUCKWILL, L. C. 1948. The hormone content of the seed in relation to endosperm development and fruit drop in the apple. *J. hort. Sci.*, 24: 32–44.

——. 1949. Fruit development in relation to plant hormones. *Endeavour*, 8: 188–193.

MACARTHUR, M., and R. H. WETMORE. 1941. Developmental studies of the apple fruit in the varieties McIntosh Red and Wagener. II. An analysis of development. *Can. J. Res.*, C, 19: 371–382.

MACDANIELS, L. H. 1937. Some anatomical aspects of apple flower and fruit abscission. *Proc. amer. Soc. hort. Sci.*, 34: 122–129.

MANN, L. K. 1942. Effects of photoperiod on sex expression in *Ambrosia trifida*. *Bot. Gaz.*, 103: 780–787.

MCCOWN, M. 1938. Abscission of flowers and fruits of the apple. (Abst.) *Proc. amer. Soc. hort. Sci.*, 36: 320.

MITCHELL, J. W., and P. C. MARTH. 1944. Effects of 2,4-dichlorophenoxyacetic acid on the ripening of detached fruit. *Bot. Gaz.*, 106: 199–207.

——, and ——. 1947. *Growth Regulators for Garden, Field, and Orchard*. Univ. Chicago Press, Chicago.

——, and M. R. WHITEHEAD. 1941. Responses of vegetative parts of plants following application of extract of pollen from *Zea mays*. *Bot. Gaz.*, 102: 770–791.

MIYAKE, K. 1904. Über das Wachstum des Blütenschaftes von *Taraxacum*. *Beih. bot. Zbl.*, 16: 403–414.

MUIR, R. M. 1942. Growth hormones as related to the setting and development of fruit in *Nicotiana tabacum*. *Amer. J. Bot.* 29: 716–720.

——. 1947. The relationship of growth hormones and fruit development. *Proc. Natl. Acad. Sci. USA*, 33: 303–312.

MÜLLER-THURGAU, W. 1898. Abhängigkeit der Ausbildung der Traubenbeeren und einiger anderer Früchte von der Entwicklung der Samen. *Landwirt. Jb. Schweiz.*, 12: 135–205.

MURNEEK, A. E. 1933. The nature of shedding of immature apples. *Missouri agric. exp. Sta. Res. Bull.*, 201: 1–34.

——, and R. O. WHYTE. 1948. *Vernalization and Photoperiodism*. Chronica Botanica, Waltham.

NITSCH, J. (P.) 1949a. Influence des akènes sur la croissance du réceptacle du fraisier. *C. R. Acad. Sci., Paris*, 228: 120–122.

——. 1949b. Obtention de fruits charnus en culture in vitro. *C. R. Acad. Sci. Paris*, 229: 445–446.

——. 1949c. Culture of fruits in vitro. *Science*, 110: 499.

——. 1950a. Growth and morphogenesis of the strawberry as related to auxin. *Amer. J. Bot.*, 37: 211–215.

——. 1950b. The role of plant hormones in fruit development. Thesis, California Institute of Technology. 1–95. (Dated 1951 by the Administration).

——. 1951a. Growth and development in vitro of excised ovaries. *Amer. J. Bot.*, 38: 566–577.

——. 1951b. Le microdosage du L-tryptophane dans les plantes. *C. R. Soc. Biol., Paris*. (In press).

——, and F. G. GUSTAFSON. 1948. Enzymatic conversion of L-tryptophane to auxin by pollen and pollen breis (unpublished).

——, D. HACKETT, and K. V. THIMANN. Is protein-bound auxin an artefact? (In press).

——, E. KURTZ, JR., J. LIVERMANN, and F. W. WENT. 1952. The development of sex expression in cucurbit flowers. *Amer. J. Bot.*, 39: 32–43.

NOLL, F. 1902. Fruchtbildung ohne vorausgegangene Bestäubung (Parthenokarpie) bei der Gurke. *Sitzber. niederrhein. Ges. nat. Heilk., Bonn*, 1902: 149–162.

OEHLKERS, F. 1922. Die postfloralen Krümmungen des Blütenstieles von *Tropaeolum majus* und das Problem der Umstimmung. *Jb. wiss. Bot.*, 61: 65–125.

OSBORNE, D. 1952. The interaction of light, temperature and synthetic growth-regulating substances for inducing parthenocarpy in tomatoes. *Bot. Gaz.* (In press).

OSBORNE, D. T., and R. L. WAIN. 1951a. The effect of substitution in the side chain of certain aryloxyacetic acids on growth-regulating activity. *Proc. IInd Int. Congress Crop Protection, London*, 1949, p. 333.

——, ——. 1951b. Studies on plant growth-regulating substances. III. The production of parthenocarpic pomaceous fruits by chemical treatment. *J. hort. Sci.*, 26: 317–327.

——, ——, and R. D. WALKER. 1952. Studies on plant growth-regulating substances. IV. The activity of certain aryloxy acids for inducing rooting and for tomato setting. *J. hort. Sci.*, 27: 44–52.

PAYER, J. B. 1857. *Traité d'Organogénie Comparée de la Fleur*. Text and Atlas. Masson, Paris.

PFEFFER, W. 1904. Das Abstossen der Blätter und anderer Organe *Pflanzenphysiologie*, 2: 276–278.

REDEMANN, C. T., S. H. WITTWER, and H. M. SELL. 1951. The fruit-setting factor from the ethanol extracts of immature corn kernels. *Arch. Biochem.*, 32: 80–84.

REINDERS, D. E. 1938. The process of water-intake by discs of potato tuber tissue. *Proc. kgl. Ned. Akad. Wet.*, 41: 820–831.

ROBERTS, R. H. 1946. Notes on apple set and growth, 1945. *Proc. amer. Soc. hort. Sci.*, 48: 59–62.

SCHAFFNER, J. H. 1927. Control of sex reversal in the tassel of Indian corn. *Bot. Gaz.*, 84: 440–449.

——. 1929. Progeny resulting from self-pollination of staminate plant of *Morus alba* showing sex reversal. *Bot. Gaz.*, 87: 653–659.

——. 1930. Sex reversal and the experimental production of neutral tassels in *Zea mays*. *Bot. Gaz.*, 90: 279–298.

——. 1936. Offspring of a self-pollinated reversed carpellate plant of *Morus alba*. *Bot. Gaz.*, 98: 425–428.

——. 1937. Stability and instability of sexual conditions in *Morus alba*. *J. Hered.*, 28: 426–427.

SCHMITT, E. M. 1922. Beziehungen zwischen der Befruchtung und der postfloralen Blüten-bzw. Fruchtstielbewegungen bei *Digitalis purpurea*, *Digitalis ambigua*, *Althea rosea* and *Linaria cymbalaria*. *Z. Bot.*, 14: 625–675.

SCHOCH-BODMER, H. 1937. Interpositionswachstum, symplastisches und gleitendes wachstum. *Ber. schweiz. bot. Ges.*, 55: 313.

SCHOCKEN, V. 1949. The genesis of auxin during the decomposition of proteins. *Arch. Biochem.*, 23: 198–204.

SCHULZ, H. 1921. Über Korrelationen zwischen der Blütenteilen und den geotropischen Bewegungen der Blütenschäfte, nach Untersuchungen insbesondere an *Papaver*. *Jb. wiss. Bot.*, 60: 1–66.

SEREISKIJ, A. C. 1938. The hormone factors of fruit formation and the problem of experimental parthenocarpy. *J. Inst. Bot. Acad. Sci. USSR Ukraine*, Special Collection in Memory of *Acad. Lubimenko*: 115–127.

SHIGEURA, G. 1948. Blossom-bud formation and fruit setting in the *Lichee*. *Rept. agric. exp. Sta. U. Hawaii*, 1946–48: 138.

SINNOTT, E. W. 1939. A developmental analysis of the relation between cell size and fruit size in cucurbits. *Amer. J. Bot.*, 26: 179–189.

——. 1945a. The relation of cell division to growth rate in cucurbit fruits. *Growth*, 9: 189–194.

——. 1945b. The relation of growth to size in cucurbit fruits. *Amer. J. Bot.*, 32: 439–446.

SMITH, W. H. 1950. Cell multiplication and cell enlargement in the development of the flesh of the apple fruit. *Ann. Bot.*, 14: 23–38.

SMITH, O., and H. L. COCHRAN. 1935. Effect of temperature on pollen germination and tube growth in the tomato. *Cornell Univ. agric. exp. Sta. Mem.*, 175: 1–11.

SÖDING, H. 1936. Wirkt der Wuchsstoff artspezifisch? *Jb. wiss. Bot.*, 82: 534–554.

——. 1938. Wuchsstoffbildung und Wuchsstoffverteilung in der Kompositenstände *Heliopsis laevis* im Laufe einer Vegetationsperiode. *Flora*, N. F. 32: 425–446.

STEHSEL, M. 1950. Thesis, Univ. of California, Berkeley.

STEWARD, F. C., and S. M. CAPLIN. 1952 (In press).

STEWART, W. S., and L. J. KLOTZ. 1947. Some effects of 2,4-dichlorophenoxyacetic acid on fruitdrop and morphology of oranges. *Bot. Gaz.*, 109: 150–162.

TANG, Y. W., and J. BONNER. 1947. The enzymatic inactivation of indoleacetic acid. I. Some characteristics of the enzyme contained in pea seedlings. *Arch. Biochem.*, 13: 11–25.

THIMANN, K. V. 1934. Studies on the growth hormone of plants. VI. The distribution of the growth substance in plant tissues. *J. gen. Physiol.*, 18: 23–24.

——. 1948. Plant growth hormones. *Hormones*, 1: 5–74. Acad. Press, New York.

THOMPSON, D. W. 1942. *On Growth and Form*. Cambridge Univ. Press, Macmillan Co., New York.

TIBEAU, M. E. 1936. Time factor in utilization of mineral nutrients by hemp. *Plant Physiol.*, 11: 731–747.

TIEDJENS, V. A. 1928. Sex ratios in cucumber flowers as affected by different conditions of soil and light. *J. agric. Res.*, 36: 720–746.

TUKEY, H. B., and J. O. YOUNG. 1939. Histological study of the developing fruit of the sour cherry. *Bot. Gaz.*, 100: 723–749.

——, and ——. 1942. Gross morphology and histology of developing fruit of the apple. *Bot. Gaz.*, 104: 3–25.

VAN OVERBEEK, J. 1946. Control of flower forma-

tion and fruit size in the pineapple. *Bot. Gaz.*, 108: 64–73.

——, M. E. Conklin, and A. F. Blakeslee. 1941. Chemical stimulation of ovule development and its possible relation to parthenogenesis. *Amer. J. Bot.*, 28: 647–656.

——, and H. J. Cruzado. 1948. Note on flower formation in the pineapple induced by low night temperatures. *Plant Physiol.*, 23: 282–285.

Veldstra, H. 1944a. Relation between chemical structure and physiological activity. I. *Enzymologia*, 11: 97–136.

——. 1944b. Relation between chemical structure and physiological activity. II. Contemplations on place and mechanism of the action of the growth substances. *Enzymologia*, 11: 137–163.

Wagenknecht, A. C., and R. H. Burris. 1950. Indoleacetic acid inactivating enzymes from bean roots and pea seedlings. *Arch. Biochem.*, 25: 30–53.

Wann, F. B. 1950. Hormones fail to increase fruit set in sweet cherry. *Farm and Home Sci., Utah agric. exp. Sta.*, 11: 60–61.

Wardlaw, C. W., and E. R. Leonard. 1936. Studies in tropical fruits. I. Preliminary observations on some aspects of development, ripening and senescence, with special reference to respiration. *Ann. Bot.*, 50: 621–653.

Weaver, R. J., and W. O. Williams. 1950. Response of flowers of Black Corinth and fruit of Thompson seedless grapes to applications of plant growth-regulators. *Bot. Gaz.*, 111: 477–485.

Webber, H. J. 1930. Influence of pollination on sets of fruits in citrus. *Cal. Citograph*, 15: 304; 322–323.

Wellington, R., and L. R. Hawthorn. 1929. A parthenocarpic hybrid derived from a cross between an English forcing cucumber and the Arlington White Spine. *Proc. amer. Soc. hort. Sci.*, 25: 97–100.

Went, F. W. 1928. Wuchsstoff und Wachstum. *Rec. Trav. bot. néerl.*, 25: 1–116.

——. 1951. Twenty years of plant hormone research. In *Plant Growth Substances* (F. Skoog, ed.), pp. 67–79. Univ. Wisconsin Press, Madison.

——. 1952. Tomato growth and fruit production under controlled temperature and light. [Communication No. 1 from Earhart Plant Res. Lab.] (In press).

——, and K. V. Thimann. 1937. *Phytohormones.* Macmillan Co., New York.

Wildman, S. G., M. G. Ferri, and J. Bonner. 1947. The enzymatic conversion of tryptophan to auxin by spinach leaves. *Arch. Biochem.*, 13: 131–144.

——, and R. M. Muir. 1949. Observations on the mechanism of auxin formation in plant tissues. *Plant Physiol.*, 24: 84–92.

Winkler, H. 1908. Über Parthenogenesis und Apogamie im Pflanzenreiche. *Prog. Rei. Bot.*, 2: 293–454.

Wittwer, S. H. 1943. Growth hormone production during sexual reproduction of higher plants with special reference to synapsis and syngamy. *Missouri agric. exp. Sta. Res. Bull.*, 371: 1–58.

Wong, C. Y. 1939. Progress report on induced parthenocarpy in some horticultural crops. *Proc. amer. Soc. hort. Sci.*, 37: 158–160.

——. 1941. Chemically induced parthenocarpy in certain horticultural plants with special reference to the watermelon. *Bot. Gaz.*, 103: 64–86.

Yasuda, S. 1934a. The second report on the behavior of the pollen tubes in the production of seedless fruits caused by interspecific pollination. *Jap. J. Genet.*, 9: 118–124.

——. 1934b. Parthenocarpy caused by the stimulus of pollination in some plants of Solanaceae. *Agric. and Hort.*, 9: 647–656.

——. 1939. Parthenocarpy induced by stimulation of pollination in some higher plants. *Mem. Fac. Sci. Agric., Taihoku imp. Univ., Formosa*, 27: 1–51.

Zimmerman, P. W., and A. E. Hitchcock. 1944. The aerosol method of treating plants with growth substances. *Contr. Boyce Thompson Inst.*, 13: 313–322.

NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Associate Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

GENETICS' GOLDEN JUBILEE

BY KENNETH W. COOPER

Princeton University

A review of GENETICS IN THE 20TH CENTURY. *Essays on the Progress of Genetics during Its First 50 Years. Edited for the Genetics Society of America by L. C. Dunn. Macmillan Company, New York.* $5.00. xi + 634 pp.; ill. 1951.

The essays brought together in this volume are nearly all records of invitation papers presented at the Golden Jubilee of Genetics, held during September 1951, at Ohio State University, under the auspices of the Genetics Society of America. Their primary purpose is stated to be twofold: the provision of a survey of the progress in genetics during the first 50 years of the science, and the exemplification of the status of some of the problems of genetics today. The book, at least in large part, may be read with profit and enjoyment by most biologists and by scientists in allied fields, for the more penetrating of the papers are lucid and first-rate, all are interesting, and only about a fifth of the 26 papers are little more than progress reports from laboratories of individual speakers. For quite obvious reasons, this review can touch only lightly upon the different essays, and lest omissions, ellipses, or critical remarks lead to an erroneous impression, let it be stated at the outset that there is proportionately little chaff, and that this book is on a par with most of the symposial volumes appearing today.

The introductory article by Professor R. B. Goldschmidt is devoted to the impact of genetics upon science, and is an enthusiastic attempt to show how genetics, its central theories and researches, have led or can lead to remarkably invigorating contributions in virtually all biological subfields. In Goldschmidt's view genetics has established itself as the main integrating discipline (in fact or in potential) of the biological sciences. In actuality the form of his argument could be used to establish, equally validly, such a central position for biochemistry, physiology, or other biological disciplines.

Three essays by H. Iltis, C. Zirkle, and W. E. Castle, respectively, deal with aspects of Gregor Mendel's life, the knowledge of heredity before 1900, and the beginnings of Mendelism in America. The tales of Mendel's life written by Iltis are charming, but it is difficult to believe that the face-to-face knowledge portrayed in them is more than sincerely written romance.

The formal and more classic aspects of genetics are treated in some 7 chapters. H. J. Muller has contributed a very fine, thought-provoking chapter on the development of the gene theory, a chapter which should give the enthusiasts for widespread cytoplasmic inheritance, in metazoa at least, considerable pause for thought. C. D. Darlington, à pas de géant, proves that he has lost neither his sparkle nor his facility for integrating and intermingling fact and guess in an exhilarating chapter on genetic determinants. A. H. Sturtevant, discussing the relation of genes and chromosomes, provides one of the few highly analytical essays. He deals in forthright fashion with key defects of current notions of meiosis (largely Darlington's), and also clearly resolves the issue regarding position effect and gene reality. Unhappily L. J. Stadler's discussion of mutation is not included among these essays, for all agree that it too was a high-light on the Jubilee program. Completing the series devoted primarily to gene genetics, there is another essay by K. Mather on multifactorial inheritance. It comes as something of a surprise, for it was not part of the Jubilee program of which this book is a record.

T. Dobzhansky, M. White, and J. Lederberg discuss aspects of the evolution of Mendelian populations, of cytological mechanisms in metazoa, and genetic studies with bacteria. Dobzhansky seems to have abandoned his earlier view that unqualified species exist in nature, quite possibly having been influenced by the logical

force of J. R. Gregg's paper on Taxonomy, Language and Reality (Amer. Nat. *84:* 419, 1950), and has shifted his emphasis to what he terms a "Mendelian population" (that is, "... a reproductive community of sexual and cross-fertilizing individuals which share in a common gene-pool"). But it would seem that another round with the logic of classes is about due, for it is very hard to believe that Dobzhansky's "Mendelian population" is any less a man-made category than the taxonomic species. However, to Dobzhansky it is by contrast natural, a "spatio-temporal entity," and to him the "biological species" is "... the largest and most inclusive Mendelian population." To many geneticists, and apparently also to Lederberg, despite his use of the notions, the employment at this time of concepts such as four-strand crossing over, sequentially different gene arrangements, segmental elimination, non-disjunction, and negative crossover interference to explain current findings in bacterial genetics will seem premature, and eloquently points to the fact that basic genetic studies and first principles are still wanting and needed in this new and hopeful field. As the interpretive notions suggest, the data presented by Lederberg are both puzzling and interesting.

Of the 4 chapters devoted to chemical aspects of genetics, those by A. E. Mirsky, and T. Caspersson and J. Schultz, respectively, are contributions to chemical morphology. Neither chapter, it seems to me, shows appropriate appreciation on the part of the authors of the subtleties of the purely genetic and cytogenetic aspects of the studies purportedly being carried out. Indeed, at times Mirsky's essay exhibits considerable laxity of thought and acceptance of outdated, unsubstantiated, or unanalyzed notions. His level of inference, for example, seems fairly represented by his astonishing conclusion that "if the measurements of DNA content per cell are correct—if this component of the chromosomes is indeed present in constant amount in the different somatic cells of an organism and in one-half this amount in the germ cells—then it may be said that DNA is part of the gene substance." Not only is the conclusion an invalid inference, but we wonder whether Mirsky would draw it otherwise if DNA proves to be more inconstant per somatic cell and gamete than he currently contends.

M. R. Irwin and G. W. Beadle discuss immunological genetics and chemical genetics, respectively, in two chapters which are of especial interest in their quite different treatment of gene products and the relations of genes to them. Irwin gives a lengthy, interesting review of the genetic aspects of blood group substances, antigen differences among species, and the so-called "hybrid substances" largely worked out in doves by himself and Cumley. Parenthetically it may be remarked that Irwin's apparent acceptance of non-disjunction as a plausible mechanism accounting for improbable blood group pedigrees (e.g., $A_2B \, ♀ \rightarrow O$ child) seems unsatisfactory, for such pedigrees would in fact require either complementary non-disjunctional gametes from *both* parents, or else the unlikely case that monosomy for the A-bearing chromosome can be tolerated in man.

For most geneticists, Beadle's generous and engrossing essay will be remembered for its fair-minded discussion of the *one gene-one primary function* hypothesis (now replacing the earlier one gene-one enzyme view), for it makes it clear that the general untestability and ambiguity of concepts that currently plague workers at this level are fully appreciated. Beadle states quite frankly that he sees no way out of the dilemma, yet intuitively feels that "... in a great many cases in *Neurospora* the reaction under primary gene control has been identified." Whether remote or close to the gene, it is nevertheless clear that the biochemical phenotypes of *Neurospora* continue to provide our best experimental and theoretical insights to metabolic and genetic machinery at work in the cell.

B. Ephrussi and T. M. Sonneborn contribute the chief discussions of cytoplasmic inheritance (also treated by Muller, Darlington, and others to a lesser degree). Ephrussi's presentation largely revolves about his own fairly preliminary work on the control of respiratory enzymes in yeast, and so far as this account of the research goes, it is straightforward and stimulating. Sonneborn deals with a fairly wide variety of germane topics in both broad and specific fashion, and attempts to formulate and illustrate in a preliminary way some 5 major roles of nuclear genes in relation to cytoplasmic inheritance. Especially interesting and significant is his account of current findings regarding ciliary antigens in *Paramecium*, and his development of the manners in which a spectrum of alternative cytoplasmic states may be subject to control by a set of genes.

Perhaps the weakest element in many of the essays in this book, as indeed in a great deal of genetic discussion today and especially that concerning cytoplasmic elements, hinges upon the meaning in any given usage that is to be read into the expression "self-duplication," for the implications consciously or (more often) unconsciously drawn from use of the unanalyzed expression seem to determine most workers' views and seriously affect their research efforts. Simply formulated, perhaps too simply, a biological system or entity can unambiguously be stated to be self-duplicating *if*, when given suitable substrates (however complex) and a suitable energy source, it can provide the enzyme systems and metabolic order necessary to replicate itself. Assuredly viruses cannot be said to be likely members of such a class of self-duplicating entities, nor even genes, plasmagenes, or kinetosomes. Possibly something less than a cell of haploid genotype is the least biological system that can be said to be self-duplicating in this qualified sense. But what of the other senses? The change in implication and outlook that comes to mind when a structure merely is labelled "replicatable" (which is all we know of most of these systems), rather than "self-duplicating" or "self-reproducing," is very considerable, for if it suggests anything of the process at all (which, preferably, it should

not do), it at most implies relative passivity and less of a mysterious potential than those slogans "self-duplication," "self-reproduction," "self-copying," and so on. The very fallacy that Lederberg (p. 282) so clearly points to regarding the notion of the production of an enzyme by a gene, includes also the production of a gene by a gene, a kinetosome by a kinetosome, a virus by a virus, and so forth.

The remaining 9 articles deal very largely with genetical analyses and evaluations of problems of practical concern to all those immediately interested in human welfare. Physicians, especially, will find much for thought and action in L. H. Snyder's discussion of human genetics, L. S. Penrose's newly added and very fine essay Genetics of the Human Race, J. W. Gowen's considerations and experiments upon disease resistance and epidemiology, and C. C. Little's review of genetic aspects of the cancer problem. Genetics and husbandry is dealt with by A. Müntzing (plant breeding), J. Lush (animal breeding), J. C. Walker (plant pathology), and P. C. Mangelsdorf (who presents a general account of the genetic basis of hybrid corn, its history, and significance in human affairs). To geneticists more closely concerned with the theoretical aspects of their subject, these chapters make interesting and timely reading. There are thought-awakening discussions aplenty in them, and perhaps none more agreeable than Lush's insistence upon our need for truly independent replication of genetic research. Witness, in recent years, the number of instances in which independent repetition of a study has reversed or significantly altered our opinions of both fact and interpretation.

The final chapter Genetics, Evolution and Human Destiny, by Julian Huxley, is a curious admixture and on the whole not an impressive concluding essay. On the one hand we find here an important and plausible suggestion regarding selection and the average age of onset of cancer, as well as an especially noteworthy statement regarding genetic differences among the races of man. It may be remarked that Snyder, Penrose, and Lush also discuss this last question, and it is heartening that a recognition of the more or less widely differing gene-pools among races of men are at last coming to be considered seriously. At the present time, as Huxley remarks, "... it is socially and intellectually fashionable to minimize or even to deny such genetic differences."

On the other hand, Huxley's article contains a considerable body of extremely dubious notions, perhaps chief among which is the insistence upon the widespread decay of evolutionary potential in the organismic world. For example, "... about 10 million years ago, the specialization of life as a primarily material organization had reached its limit, beyond which it could not be driven by the material methods of natural selection," and so on. Indeed, Huxley's views about the low potential of extra-human evolution are summarized in his statement that "... in all other animals and in all plants, major progressive evolution, it appears, had come to an end [by the Pliocene]." Huxley's dim outlook for progressive evolution among organisms is not implicit in anything we know and need not be discussed here, for it seems to arise from an unexpressed belief in phylogenetic advance by terminal ontogenetic accretions. Huxley's colleague, G. R. De Beer, has ably analyzed this very point in his book (*Embryos and Ancestors*, Oxford), and so-called "clandestine evolution" coupled with neoteny, among other possibilities, gives a plausible, workable escape from the advanced evolutionary entropy that Huxley portrays.

REVIEWS AND BRIEF NOTICES

General Biology: Philosophy and Education 60
Biology: History and Biography 65
The Young Naturalist 71
Ecology and Natural History 74
Evolution 79
Genetics and Cytology 81
General and Systematic Botany 84
Plant Physiology 89
Economic Botany 89
General and Systematic Zoology 94
Economic Zoology 103
Animal Growth and Development 105
Animal Morphology 106
Animal Physiology 109
Animal Nutrition 111
General Physiology 113
Biophysics 113
Biochemistry 115
Microbiology 119
Health and Disease 122
Psychology and Animal Behavior 125
Human Biology 130
Biometry 135
De Omnibus Rebus et Quibusdam Aliis 135

GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

DEATH OF A SCIENCE IN RUSSIA: *The Fate of Genetics as Described in Pravda and Elsewhere. Edited by Conway Zirkle. University of Pennsylvania Press, Philadelphia.* $3.75. xvi + 319 pp. 1949. This volume consists mainly of translations of the speeches made during the 8 days of sessions at Moscow of the Lenin Academy of Agricultural Sciences in July, 1948, on the ill-fated question of the status of genetics and the situation in biological science in the U.S.S.R. The book should be placed on the list of required reading for every biologist, since the trend of events and the flavor of the criticism of "Mendelism-Morganism-Weismannism" cannot be appreciated at secondhand. It must be read to be believed.

Here are reproduced not only Lysenko's keynote speech, but also the clever dialectical arguments of Mitin and Prezent, the ridiculously ignorant assertions of a number of Lysenko's other supporters, and the defense and ultimate repudiation, craven, half-hearted, or ironic, of established genetic views by a majority of the biologists who were attacked. Only from Schmalhausen, Nemchinev, Dubinin, and a resolute few, one hears no word of recantation, then or later. These men, martyrs of science, have vanished in an enactment which has no parallel, just as Zirkle says, since the days of Galileo. For further comment on the debacle of genetics in Russia, see the review of the official volume of transactions of the 1948 Conference (L. C. Dunn, *Q.R.B.*, 25: 61–62. 1950).

To Conrad Zirkle we are all profoundly indebted for his editorial labor in collecting and overseeing the translation of the papers and addresses, and for supplying an intelligent background against which they may be considered. In its entirety, the volume provides extensive insight into the origins and nature of the major scientific controversy of our time, as well as a full picture of its culmination in the U.S.S.R. The outcome in the Western world of the struggle to keep science free of state control and dictation is not assured. A far wider circle than that of the geneticists alone should therefore read with open eyes the pages of *Death of a Science*. . .

BENTLEY GLASS

THE NATURAL SCIENCES IN WESTERN GERMANY. *A Symposium on Current Research under the Direction of Kurt Ueberreiter, Foreign Consultant to the Library of Congress.*

Reference Department, European Affairs Division, Library of Congress, Washington, D. C. Paper. 127 pp. 1951.

This publication gives a grossly inaccurate and inadequate picture of the current status of biological work in Germany. It devotes 5 pages to Biological Chemistry (74 references) and 8 pages to Biology (78 references). The following paragraph has to be read to be believed:

"The following fields of biology are not considered: serology, special enzymology, virus research, bacteriology, microbiology, antibiotics, protista, metabolism of plants, physiology of evolution of plants, physiology of susceptibility of plants, morphology of plants, psychology of animals, heredity, theory of descent, oecology, geography of plants, geography of animals, hydrobiology, oceanography, parasites and vermin, applied botany, applied zoology, systematics of plants, systematics of animals, all of human anatomy and physiology, pathology of plants, pathology of animals, pathology of man."

What remains has been collected into 11 categories: general, natural philosophic-biological problems (including textbooks and handbooks); methods; biochemistry; physical chemistry of cells and tissues, physiological chemistry and physiology of metabolism; metabolism of animals; propagation and sexuality of animals; physiology of evolution of animals (i.e., experimental embryology and developmental physiology); cytology; sensory physiology of animals; and morphology of animals. It is obvious that even a full and careful consideration of these could give no real idea of the scope of biological research in Germany today, especially since many of the most active fields have been excluded from consideration. Nor does the bulletin show any more accurately the relative activity of the biological as compared with the physical sciences at the present time. Twenty per cent of the pages of this survey are devoted to biochemistry and biology, but a recent check of *Naturwissenschaften* indicates that the number of biological papers published has increased from 40 per cent, before World War II, to a present high of 50 per cent.

BENTLEY GLASS

THE HISTORY OF NATURE.

By C. F. von Weizsäcker. The University of Chicago Press, Chicago. $3.00. vi + 192 pp. 1949.

In *The History of Nature* a great astronomer worthily follows the tradition set by other great astronomers of this century, the tradition of lucid, popular exposition of his own subject accompanied by extensive excursions into philosophy and religion. About half—the first half—of this little book is an excellent account of modern views of the origin of the universe and solar system, including Weizsäcker's own. The second half of the book turns attention first to the origin of life on the earth, sketches the course of organic evolution, and glances at the history of man. With regard to the nature of life, Weizsäcker is not exactly a vitalist, but he is a teleologist. That is to say, he holds that questions which can be asked in physical terms can and must be answered in physical terms; but questions of a teleological sort are not answerable thereby. This position necessarily brings him to reject the view that evolutionary process is solely by means of chance, change, and natural selection. Natural selection cannot create, and what is chance? To Weizsäcker the entire creation is thus the realization of what has existed potentially from the beginning. Unfortunately, Weizsäcker does not analyze the concept of organism, and therefore dodges the heart of the problem. Does not the creation of an organism consist precisely in the assemblage and integration of its parts rather than in the creation of its components—whether cells, molecules, atoms, or ultimate particles. The miracle is simply that the universe itself exists and possesses order. Had Weizsäcker directed his analysis at this fundamental of his own field instead of seeking support for his views in biology,

where he is clearly not so well versed, he would carry greater conviction.

Weizsäcker is profoundly concerned about the ethical development of man's history. His last chapter is a moving presentation of a frankly Christian ethic as the hope of the world.

BENTLEY GLASS

CELL AND PSYCHE—*The Biology of Purpose.*

By Edmund W. Sinnott. University of North Carolina Press, Chapel Hill. $2.00. viii + 121 pp. 1950.

When faced with the major biological problem of organization and its apparent purposiveness, some biologists have retreated into vitalism. When faced with the equally pregnant problem of reconciling the subjectivity of experience with the objectivity of science and of exploring the relation between mind and body, some biologists and psychologists have confessed their bafflement and have frankly accepted dualism. A majority of the younger generation of biologists seems to fear to face such problems at all. They unthinkingly accept mechanism and monism as established truths, instead of recognizing them to be no more than the philosophical assumptions appropriate to the nature of scientific investigation and its limitations. Thus we acquire scientific dogmas.

Only a rare individual, while finding vitalism repugnant and dualism unsatisfying, is nevertheless willing to examine the foundations of the mechanistic and monistic views and to note their weaknesses. Edmund W. Sinnott is one of these are biologists, one who shows his boldness in the selection of the subtitle "The Biology of Purpose" for his slender volume. Sinnott writes with clarity and beauty of language, which make the reading easy and pleasant. Whether he can persuade many to his view remains, however, questionable.

The essence of Sinnott's view lies in the hypothesis he proposes, namely, "that in the regulatory and organizing processes in protoplasm lies the foundation of what are called the psychological or mental activities in animals and especially in man"; and again, in other words, "that biological organization (concerned with organic development and physiological activity) and psychical activity (concerned with behavior and thus leading to mind) *are fundamentally the same thing.*" "There must certainly be some sort of controlling mechanism, structure, or system in the egg (and doubtless in every cell) which definitely foreshadows the character of the particular organism into which it will develop or of which it forms a part. It is this organization, whatever it may turn out to be in terms of matter and energy, space and time, which, *as experienced by the organism*, I believe to be the simplest manifestation of what in man has become conscious purpose." In this view the genotype and the homeostatic physiological system become the antecedents and rudiments of the Gestalt in the realm of mind, the organization and purposiveness of living systems at all levels coming from the action of evolutionary processes.

Mind and body are simply two aspects of the same phenomenon, seen from the inside or seen from the outside. Purpose exists in living things because it is "built into" the genotype and the protoplasm. (I cannot agree with the distinction Sinnott makes between purposive organization and adaptation because of the fact that "organisms often fail to act in such a way as to favor their survival." The observation is true; but it remains to be proved that the organization did not evolve under conditions wherein it was adaptive, in which case to make mistakes, apart from statistical error, is simply the result of a removal of the organization out of its original context. There is abundant evidence to support this view.) Undeniably, the general view advanced by Sinnott can be made acceptable to mechanist and idealist alike, and will aid in placing in better perspective the questions of values, of free will versus determinism, of individuality, and of "that deep final question of what man's nature really is and what is his place and significance in the universe." All of these the author discusses, with illumination but only too briefly, placing himself finally on the side of the idealists and believers in the creative power of God. Whether the reader agrees with such a point of view or not, it will profit him greatly to reason with the author through these stimulating pages.

BENTLEY GLASS

THE LIMITATIONS OF SCIENCE.

By J. W. N. Sullivan. A Mentor Book, The New American Library, New York. 35 cents (paper). 192 pp. 1949.

Reprint of an important contribution to the philosophy of science, first published in 1933 (*Q.R.B.*, 9: 258. 1934).

KNOWING AND THE KNOWN.

By John Dewey and Arthur F. Bentley. The Beacon Press, Boston. $4.00. xiv + 334 pp. 1949.

Those who feel, as do these authors, "that, as progress is made, the full system of human inquiry may be studied as if substantially one," will find in this book much that is stimulating and provocative, much that is very reasonable, but little that attempts to be definitive. The book is an assortment of material in large part previously published in philosophical journals as separate articles, some signed singly by one or the other author, and some signed jointly. The authors have felt that repetitive statements from an evolving point of view had a certain value, and they have not welded the material into a succinct and organized whole. The general outcome of the book is an attempt to indicate

wherein certain points of view basic to physical science are still surprisingly lacking in the social sciences, and concurrently to develop an illuminating analysis of the physical sciences.

Knowing and the Known begins with a detailed criticism of the "linguistic chaos" which the authors find in the field of contemporary logic. "The great variety of confusions" results from the "uncritical use of traditional terms and phrasings of relatively primitive cultural origins," which in turn reflects the prevalence of "defective underlying assumptions that influence the writer's approach." The two chief types of fallacious assumptions are those which continue "the classic demand for permanence in knowledge" and the "post-Aristotelian dismemberment of man's naming activities from his named world."

In place of the fictitious absolutes, the authors propose an operational view of knowledge, which treats knowledge "as a goal *within* inquiry, not as a terminus outside or beyond inquiry." "Knowledge and obtaining knowledge . . . must be conceived . . . in terms of the operations by which, in the continuum of experiential inquiry, stable beliefs are progressively obtained and utilized. . . . Warranted assertion . . . both as to the warranty and the warranted, exhibits itself as a phase of situations in all degrees of development from indeterminate to determinate. The strongest warranted assertion is the hardest of hard fact, but with neither the determinacy, nor the warranty, nor the hardness, nor even the factuality itself ranging beyond the field of inquiry—for what is 'hard fact' at 'one' time is not assuredly 'hard' for 'all' time."

With respect to the widespread dismemberments, the authors declare: "What has been completely divided in philosophical discourse into man *and* the world, inner *and* outer, self *and* not-self, subject *and* object, individual *and* social, private *and* public, etc., are in actuality parties in life transactions. The philosophical problem of how to get them together is artificial. On the basis of fact, it needs to be replaced by consideration of the conditions under which they occur as distinctions, and of the special uses of the distinctions. . . . Petrifaction of distinctions of this kind . . . into inherent (and hence absolute) separations is the vicious affair.

"Philosophical discourse . . . either directly or through psychology as an ally, has torn the intellectual, the emotional, and the practical asunder, erecting each into an entity, and thereby creating the artificial problem of getting them back into working terms with one another. Especially has this taken place since the scientific revolution of a few centuries ago. For the assumption that it constituted natural science as an entity complete in and of itself necessarily set man and the world, mind and nature as mindless, subject and object, inner and outer, the moral and physical, fact and value, over and against one another as inherent, essential and therefore absolute separations.

"This splitting up of things that exist together has brought with it . . . the dissevering of philosophy from human life, relieving it from concern with administration of its affairs and of responsibility for its troubles. It may seem incredible that human beings as *living* creatures should so deny themselves as alive."

In place of such vicious separations, the authors propose the "transactional" point of view, which treats "all of man's behavings, including his most advanced knowings, as activities not of himself alone, nor even as primarily his, but as processes of the full situation of organism-environment. . . . Word and thing belong broadly together, with their provisional severance of high practical importance in its properly limited range, but never as full description nor as adequate theoretical presentation, and always *in* action. . . . The primary consideration . . . with respect to Fact is that the activity by which it is identified and the *what* that is identified are both required . . . and are in no sense separable. . . . In our belief the Newtonian era has settled the status of fact definitely in this way, for our generation of research at least. First, Newtonian mechanics rose to credal strength in the shelter of its glorious absolutes. Then at the hands of Faraday, Clerk Maxwell, and Einstein, it lost its absolutes, lost its credal claims, and emerged chastened and improved. It thus gained the high rating of a magnificent approximation as compared with its earlier trivial self-rating of eternal certainty. The coming years—fifty, or a thousand, whatever it takes, remain quite free for change. Any intelligent voice will say this, the trouble is to get ears to hear."

An impressive part of the book is a display of the extent to which the transactional presentation of objects, and the determination of objects as themselves transactional, has been entering recent physical research. The transactional presentation is contrasted with the primitive view of the self actions of mythology, and with the presentation of classical mechanics in terms of interactions. The word transaction was used by Clerk Maxwell much in the sense that the authors use it. "Our assertion is the right to see in union what it becomes important to see in union, together with the right to see in separation what it is important to see in separation—each in its own time and place: and it is this right for which we find strong support in the recent history of physics."

"In pursuing this line of inquiry, it proved to be a natural affair to take as a point of departure the physiological connection and distinction of organism and environment. . . . Today we find transactional as well as interactional procedures used in the *details* of biological inquiry, but for *general* formulations we find little more than preliminary approaches to the transactional. This is seen on the large scale in the heavily theoretical separation that is maintained between the organism and the environment and the attribution of many activities to the former as if in independence. . . . The

gene, when it was first identified by name and given experimental study 'on suspicion', seemed almost as if it held the 'secret of life' packed into its recesses. . . . But . . . with gene position and gene complex steadily gaining increased importance for interpretative statement, the gene, like many a predecessor that has been a claimant for the rank of element or particle in the universe, recedes from its claims to independence *per se*, and becomes configurational within its setting." Quoting Julian Huxley, "for the significance of its wordings rather than for fixation of authority, 'To say that rose comb is inherited as a dominant, even if we know that we mean the genetic factor for rose comb, is likely to lead to what I may call the one-to-one or billiard ball view of genetics. . . . This crude particulate view of unanalyzed but inevitable correspondence . . . is a mere restatement of the preformation theory of development.' "

The authors touch many fields with their analysis, with natural emphasis on their own fields of philosophy, psychology, linguistics, and logic, fields in which linguistic health would seem to be a *sine qua non* for progress. A significant omission is chemistry, that unpretentious science which has accomplished so much by means of its tight operational specifications, quite without benefit of any dismembered verbalization. In the biological field the result is a sketchy but highly provocative study from a point of view which might well repay deeper and more extensive treatment, perhaps preferably by a physiologist. There is much in the point of view of Claude Bernard, for example, which is related to Dewey and Bentley's analysis of happenings as transactions, although there is by no means complete correspondence.

Dewey's final comment is as follows: "As I reflect upon the historical course of philosophy I am unable to find its course marked by notable successes in the matter of conclusions attained. I yield to none, however, in admiring appreciation of the liberating work it has accomplished in opening new perspectives of vision through its sensitivity to problems it has laid hold of in ways which, over and over again, have loosened the hold upon us exerted by predispositions that owe their strength to conformities which became so habitual as not to be questioned, and which in all probability would still be unquestioned were it not for the debt we owe to philosophers."

EVELYN HOWARD

THE PHILOSOPHY OF EDMUND MONTGOMERY.
By Morris T. Keeton. University Press in Dallas, Southern Methodist University, Dallas, Texas. $5.00. xii + 386 pp.; 1 pl. 1950.

This is the intellectual biography of a rather romantic, yet substantial, American scientist-philosopher who anticipated by decades contemporary theories of integrative levels in nature. The concept of specific reactivity was central to his whole system of thought, and he interpreted the various levels in nature as so many regions of inherent reactivity. His experimental work on cellular morphology and on cell-like inorganic structures led him to repudiate aggregationalist biology, altogether. Inherent reactivity, with occasional emergence of new synoptic patterns, was also discovered in the genesis of symbolic forms in human knowledge-seeking. Montgomery rejected an all too simple semantics which sought perceptual equivalence for all types of symbols.

Most of Edmund Montgomery's mature research and writing was carried on at his Texas plantation, where he resided from 1873 until the turn of the century. Many of his papers, however, were published in British or in German journals. Born in Scotland, his education had been continental. He married and brought to Texas the well-known Austrian sculptress Elizabeth Ney. All sorts of curious rumors are associated with the early background and the personal affairs of this remarkable man.

Edmund Montgomery repudiated both the Platonic conception that ideal possibilities shape concrete processes and the atomistic idea that form is an accident in nature. To Montgomery, nature was the field of interplay among organized wholes, each evincing inherent reactivity of a unique type. The higher forms of life were "prepotent with might gathered from afar." Self-seeking motivation in man was thought of as an immature form, unaware of either its own origin or its own destiny. Mature man celebrates existence through dedication to the emerging ideal.

ROBERT F. CREEGAN

SCIENCE MARCHES ON.
Edited by James Stokley. Ives Washburn, New York. $3.75. 331 pp. 1951.

The Science Forum radio program of the General Electric Company has brought to a wide audience the men who have been instrumental in pushing forward our frontiers of knowledge, and who have been making contemporary science. To hear them discuss in person their special fields of interest has been a rare privilege, but through the efforts of James Stokley it is now possible to read at leisure what was said. These scientists have written with their audience in mind, and they have made an attempt—a successful one—to relate their discoveries in terms which the average layman can understand and appreciate. They have been particularly concerned with answering the questions: What has science done for the radio listener? and What is science likely to contribute to future physical betterment and mental enlightenment? The 50 selected essays cover a wide range of subjects, and

collectively provide a tremendous amount of interesting and adroitly handled material.

C. P. SWANSON

SCHOOL LABORATORY MANAGEMENT. *2nd Edition.* *By Arthur Sutcliffe. John Murray, London.* 6s. xii + 164 pp. 1950.

This highly useful book is the outcome of a course on laboratory instruction given by Sutcliffe at the Cambridge University Training College for Schoolmasters. It is intended to help all science teachers, particularly at the beginning of their careers, with the problems of laboratory management. It is well suited to serve the purpose.

It treats: the equipment, organization and management, preparation and storage of reagents; the physical laboratory; the biological laboratory; a nature calendar; purchasing materials; accidents and how to handle them; how to prepare some standard solutions in chemistry; a list of equipment for each student in chemistry; and a list of experiments in chemistry.

I can still recall with discomfort the fumbling, trial-and-error beginnings of laboratory direction in those first few years of teaching. How such a book as this would have helped! It should be useful to all beginning science teachers in England, doing for them what one or two good books now do for American science teachers.

ELLA THEA SMITH

BIOLOGY: HISTORY AND BIOGRAPHY

THE ORIGINS OF MODERN SCIENCE 1300–1800. *By H. Butterfield. Macmillan Co., New York.* $3.00. xii + 187 pp. 1951.

Modern science, in its best sense and as distinguished from that of the ancients, is characterized by a spirit of free inquiry unhampered by authority, by a respect for experimentation as opposed to dictation as the only sure means of problem-solving, and by a healthy scepticism as to the finality of conclusions. These attributes, commonplace as we now consider them to be and part and parcel of our scientific approach, are however relatively new qualities added lately to the minds of men. They formed no portion of the mental equipage of the ancients, and they were gained only by removing the shackles of Aristotelian and Ptolemaic authority. The transformation was difficult, but that it was eventually accomplished led to the scientific revolution of the 16th and 17th centuries, a revolution which, according to Butterfield, "outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to the rank of mere episodes, mere internal displacements, within the system of medieval Christendom."

The transformation took place first in celestial and terrestial physics, to be then extended at a later date to chemistry and biology, and to the political, social, and economic areas of thought. With the publication of Newton's *Principia* in 1687, the revolution became an accomplished fact, although its roots extend far backward in time and its full acceptance was a slow process. It took, among many other things, the painstaking observations of Tycho Brahe, Kepler, and Galileo, the hypotheses of Copernicus, the restless probing of Bacon, the economy and austerity of Cartesian geometry, and finally the synthesizing mathematical genius of Newton to bring it to its full fruition and to stamp its indelible mark upon human thought.

Butterfield has followed no customary chronological pattern in outlining his subject. Rather, he has sought to develop his thesis not only by showing what were the contributions of the various figures to scientific progress, but by considering what systems of thought had to be overthrown before new concepts could be created, what reception these ideas met in contemporary and future minds, and most important what mental transpositions had to be made in men's minds to allow the construction, acceptance, and furtherance of new hypotheses and new methods of approach. It is, in the author's words, only when we know how "a great thinker operated on the margin of contemporary thought, or created a new synthesis, or completed a line of development already taking place" that we can fully understand the wellsprings from which arose what we call modern science, and can appreciate its influence on present-day civilization. It is to be hoped that this volume gains a wide audience, for in this day of technology and instrumentation we are all too likely to forget that real progress stems from thinking men who consider the fundamentals of science and not from applied scientists who of necessity operate within proscribed limits.

C. P. SWANSON

A MEDICAL HISTORY OF PERSIA AND THE EASTERN CALIPHATE *from the Earliest Times until the Year A.D. 1932.* *By Cyril Elgood. Cambridge University Press, New York and London.* $10.00. xii + 617 pp. + 6 pl. 1951.

This book contains a great number of gruesome, but completely irrelevant data on the checkered, yet monotonous political history of the region under discussion. Interesting medical materials are reported for the Arabic period as well as concerning the activity of British, French, and German doctors in Persia during the 19th century. The author, who has lived for many years in Persia knows the Arabian language; still, from what he does to the few Greek data he uses, I would be somewhat sceptical as to the quality of his scholarship.

His claim for the Persians as the scientific teachers of the Jews, the Greeks, and the rest of the world will hardly be shared by many. The worst aspect of the book is the author's inability to organize his material properly.

ERWIN H. ACKERKNECHT

PARACELSUS—*Selected Writings. Bollingen Series XXVIII. (Originally published in German as Theophrastus Paracelsus: Lebendiges Erbe.)*

Edited, with introduction by Jolande Jacobi; translated by Norbert Guterman. Pantheon Books, New York. $4.50. 347 pp.; ill. 1951.

In this book Miss Jacobi has combined passages from the very numerous writings of the famous 16th century physician, alchemist, and mystic into chapters on such subjects as Man and Creation, Man and Spirit, Man and Fate, and God the Eternal Light. They will serve the purpose for which the book is written: the edification of upper crust adepts of mysticism who have always been so fatally symptomatic of periods of decadence like ours.

For those who want to study the disagreeable, but interesting and important historical phenomenon that was Paracelsus, this book, which looks quite nice with its many reproductions of contemporary woodcuts, is worthless. The serious student will find the only source in English at present to be the Paracelsus translations published by the Johns Hopkins Press and omitted from Jacobi's bibliography. The "composite picture" technique of the anthology makes Paracelsus sound far more consistent than he ever was, but in return he appears much more limited in outlook than in reality he was. The double translation (from old into modern German by Jacobi, and from modern German into modern English by Guterman) makes Paracelsus appear even more commonplace than he was—and than mystics usually are—when deprived of verbal camouflage.

ERWIN H. ACKERKNECHT

JOHANNES KEPLER: *Life and Letters.*

By Carole Baumgardt; introduction by Albert Einstein. Philosophical Library, New York. $3.75. 209 pp. + 3 pl. 1951.

The name of Kepler—student and successor to Tycho Brahe, contemporary of Galileo, and predecessor of Newton—is linked to the solution of the problem of the true movements of the earth and the other planets in space. The solution, arrived at by a process of triangulation, showed that the planetary orbits are ellipses rather than circles about the sun. These studies, embodied in the three Keplerian laws which form the "foundations of modern astronomy as an exact theoretical science," were carried out under extreme conditions of scientific privation, personal hardship, and religious persecution. The circumstances of his life and his studies are revealed in Kepler's letters to his friends, patrons, and associates, with the author providing the continuing thread of the story in an unobtrusive yet illuminating manner. It is the story of a man who never allowed himself to become discouraged or embittered by his failure to gain stature in the eyes of his contemporaries, even though he himself was clearly aware of the significance of his unappreciated discoveries. It is furthermore the story of a man who sought only a deeper knowledge of natural events regardless of the consequences of that knowledge. The book, brief though it is, and dealing only scantily with the scientific aspects of Kepler's work, is an able biography, and well worth the time spent in its reading. Albert Einstein has contributed an understanding and appreciative introduction to the volume.

C. P. SWANSON

QUAKERS IN SCIENCE AND INDUSTRY, *Being an Account of the Quaker Contributions to Science and Industry during the 17th and 18th Centuries.*

By Arthur Raistrick. Philosophical Library, New York. $6.00. 361 pp. + 16 pl. 1950.

Within recent years the Quakers have assumed a prominence entirely out of proportion to their numbers, due no doubt to the fact that their historic opposition to such evils as slavery, addiction to alcohol, the taking of oaths, and participation in war has shifted from a negative to a positive attitude, with a concomitant emphasis on reconstruction and rehabilitation, not only in the regions devastated by two world wars, but also in those domestic areas in which an economic revolution has long been under way and which is only now approaching its climax.

The present work was prompted by the question, Have the Quakers made any contribution to industry and science which can be considered in any sense to be of a peculiarly Quaker nature? To obtain even an approximate answer to this question a great deal of research has been necessary.

The author of this work is a past president of the Friends Historical Association of London, and his researches have been almost exclusively confined to English Friends. Only three of those who figure in the narrative were born outside the British Isles—John Bartram, George Dillwyn, and John Coakley Lettsom, while the first of these lived before his native land had severed its ties with the British Empire, and the two last spent most of their lives in England. All were Fellows of the Royal Society.

Friends have always been more prominent in industry than in science. This is probably true of all religious groups. But there was another factor which tended to drive Quakers into industry. Their testimony against

oaths debarred them not only directly from the professions, but also indirectly from agricultural pursuits. A farm is more readily subject to distraint than a shop, and more difficult to get going again after distraint. Also, a retail shop requires less skill for its operation than a farm, and those Quakers who were imprisoned for refusal to bear arms found substitute managers for shops to be more available than for farms. True, among early Friends the farmers outnumbered the shopkeepers 5 to 1, but in the total population of England the corresponding proportion was 10 to 1. Either the early Friends were more largely drawn from the industrialists or the farmers tended to turn toward industry upon joining the Society of Friends.

It was not until the Acts of Toleration had been passed by Parliament that the professions were opened to Friends. For this reason the chapter dealing with Quakers in medicine is quite brief. Strangely, no mention at all is made of the most famous name in the history of British medicine—Joseph Lister—probably because he terminated his formal connection with the Society at the time of his marriage, although he later declared that he had never ceased to consider himself a Friend. Martin Lister is mentioned several times in the course of the book, although he was not a Friend.

Some of those who figure in this story excelled in more than one line of activity. The fact that Peter Collinson was a famous botanist has tended to obscure the fact it was he who suggested to Franklin the kite-flying experiment. John Fothergill was not only an influential physician but also a proficient chess player. The most versatile member of this company seems to have been William Cookworthy. A manufacturer of porcelain, an industry which he revolutionized by his chemical knowledge of clay and his discovery of beds of new kinds of clay, he also invented a still for the purification of sea water, assisted Smeaton in the design and construction of the Eddystone lighthouse, advised Sir Joseph Banks concerning his observation of the transit of Venus, and prepared the text of an English translation of the works of Emmanuel Swedenborg, a writer whom he greatly admired.

I was astonished to come across the portrait of Linnaeus in this work. Linnaeus was not a Friend, although he seems to have known some of their beliefs and to have shared them. Although he was certainly one of the great luminaries of 18th century science, a book dealing with Quakers hardly seems an appropriate place for his portrait.

The few errors in this work are chiefly errors of omission. The author speaks of the Fry family and of the chocolate industry with which their name is associated, but nothing about the Cadbury and Rowntree families notable in the same field. Raistrick speaks of the social and economic reforms of John Bellers, but tells us nothing about the influence of this Friend on the greatest of his disciples, Robert Owen of Lanark. In giving credit to Jeremiah Dixon for his share in fixing Mason and Dixon's Line, the author states that the name "Dixie Land" by which the negroes designate the area north (sic) of this boundary was derived from that of Jeremiah Dixon. There is of course another theory to account for the origin of this name. An index of 11 pages has been very carelessly compiled and omits many of the names of persons mentioned in the text.

The reader who wishes to know how the author answers that question propounded in the Introduction is advised to read the Summary and Conclusion, which is the most important and best written chapter in the entire work.

JOSHUA L. BAILY, JR.

LOUIS PASTEUR. *Free Lance of Science.* *By Rene J. Dubos. Little, Brown and Company, Boston.* $5.00. xii + 418 pp. + 7 pl. 1950.

"Throughout western civilization, in the 19th century men of science established contact with a large and responsive public—by means of lectures, books, and pamphlets. . . . As one reads the accounts of these great scientific performances—the magnitude of the problems which were raised, the intellectual majesty of the scientists who were the main performers, the brilliance and responsiveness of the audience—one returns with a sense of frustration to the dull scene where science and public come into contact in the present world." In this study of Pasteur as a product and protagonist of the nineteenth century, "one of the greatest experimenters who ever lived," Dubos has made a commendable contribution to the non-technical literature of science. Unfortunately, the quality of different chapters is uneven, and for me at least the book as a whole does not have the compelling quality of writing that has been deeply felt and well thought out. "Few lives have been more completely recorded than that of Pasteur," and Dubos does not attempt to present a chronological account of the events in the life of his subject; yet nevertheless he has included a good deal of biographical material that seems pale and less significant than it did in the context of Valléry-Radot's pages. However, there are some very interesting descriptions of Pasteur's methods of working, and Dubos' primary interest appears in some excellent chapters that portray the background and evaluate the significance of Pasteur's work in the light of our time. There is a superb chapter on the intellectual configuration of the milieu in which the separation of the right- and left-handed crystals took place. The interests of Pasteur's teachers created, as it were, a supersaturated solution in which all the essential components of Pasteur's discovery were present, but in ionized form. In May, 1848, the young student made his epoch-making separation of the crystals, and became, in his own words, "so happy that I am shaking all over and am unable to set my eyes again to the polarimeter."

Dubos, however, by no means presents the full personal background of this period—Pasteur's frugal life, how he taught a class from 6 to 7 AM., nor does he mention Pasteur's enthusiasm for the republican revolution of 1848, his being stationed as a member of the *Garde Nationale* at the Orléans Railway, his gift of all his meagre savings to the republican cause in April 1848, and that it was directly after these days of national exaltation that he separated the crystals.

As a whole, the book would rate much higher in my estimation were it not for the last chapter, Beyond Experimental Science, wherein the shadow of mysticism falls darkly across the pages. This chapter is curiously at variance with most of the rest of the book. It includes a superficial survey of the extent to which verbal adherence to religious views was endemic among outstanding scientists of the last century, without reference to what God suffered at the hands of these his defenders in the way of progressive restriction of the areas of theological authority. The naiveté of scientists outside the fields of their special competence is perennially surprising. It is as if they had exhausted their powers of rigorous thinking in their struggles with their specialties. However, it is one thing to note among scientists a verbal compliance with the emotional patterns of their time, but it is something else again when Dubos quotes the following *unpublished* remarks of Pasteur, with the comment that they "foreshadowed some of the modern developments of the theory of knowledge . . . 'How do you know that the incessant progress of science will not compel scientists . . . to consider that life has existed during eternity and not matter? You pass from matter to life because your intelligence of today . . . cannot conceive things otherwise. How do you know that in 10,000 years one will not consider it more likely that matter has emerged from life. . . .?'" Such a primitive dismemberment (see Dewey) does not vitalize contact between the public and leading contemporary thinkers. Let us not confuse life with electromagnetic energy. That makes it too easy to fly above the clouds, and to forget that when we bomb a city many people become dead.

As a bacteriologist's analysis of the "mechanisms" of Pasteur's discoveries, Dubos' study has merit. As a portrayal of the human being, the Beethoven of microbiology, it presumably was not intended to replace in any way Réné Valléry-Radot's classic.

EVELYN HOWARD

S. WEIR MITCHELL—*Novelist and Physician.* *By Ernest Earnest. University of Pennsylvania Press, Philadelphia; Geoffrey Cumberlege, Oxford University Press, London.* $3.50. xii + 279 pp. + 3 pl. 1950.

Silas Weir Mitchell (1829–1914) of Philadelphia did remarkable work on snake venom in the 1850's, at a time when medical scientific research was almost unknown in the United States. Later he became an internationally outstanding neurologist and psychiatrist. At the age of 51 he started an eminently successful career as a novelist. He belongs to the generation whose minds received an indelible stamp from the miseries of the Civil War, but which on the other hand stimulated his best neurological work. His gift for friendship made him a close companion of some of the most outstanding medical and literary Americans of his time and the sponsor of such talents as Noguchi and Cushing. He came from an erratic, but colorful family.

It is obvious that the life of such a man is perfect material for a biography. The author has dealt competently but in a somewhat external way with Mitchell the scientist. Being a professor of English, he is more profuse regarding Mitchell the novelist. He recognizes that except for *Constance Trescott*, Mitchell's novels have now lost interest because of their all-too-Victorian character. Mitchell indeed was proud that he had never written a line that would make a young girl blush. It is hard to reflect real life under such limitations. Earnest realizes that Mitchell absorbed this and other deforming attitudes from the specific social climate of Philadelphia; and yet he maintains a somewhat tiresome admiration for this milieu that can hardly be shared by "outsiders."

The book is honestly, though not very well, written. The interesting subject matter alone makes it worthwhile reading. A last summarizing chapter is excellent.

ERWIN H. ACKERKNECHT

PHYSICIAN TO THE WORLD. *The Life of General William C. Gorgas.* *By John M. Gibson. Duke University Press, Durham, North Carolina.* $4.50. x + 315 pp. + 6 pl. 1950.

The contributions of William Gorgas to the field of medicine could not be fully realized until World War II. The record of the United States with respect to Army and Air Forces casualties, in that war (225,155 dead as a result of enemy action, compared with 69,377 non-battle deaths) fully justifies Gorgas' prevision that the centuries-old ratio of several deaths from disease for every death to enemy action (in time of war) would become a thing of the past, so far as America is concerned.

This delightful biography may be added to the long list of national and international tributes which have been paid to the man whose determination to become an army officer led him first to become a doctor, so that he could fulfil his ambition. Although Gorgas was admittedly not the originator of the idea that the mosquito is the vector in the transmission of yellow

fever, his tenacity to that principle, and the success of his thorough clean-up campaigns both in Cuba and the Panama Canal Zone, resulted in the complete vindication of the principle.

An important part of the story, and one which is carefully woven into every chapter of the present volume, is that concerning Gorgas' breadth of understanding and depth of feeling in the area of human relations. This factor is particularly apparent in his associations with both his superior and his inferior officers, as well as with his family, and especially his mother.

Gorgas' triumphs in the face of difficulties and discouragements that would have completely frustrated a person of lesser stature, have truly earned for him the epithet implied in the title of the present volume, "Physician to the World."

B. AUBREY SCHNEIDER

FROM THE LIFE OF A RESEARCHER.

By William Weber Coblentz. Philosophical Library, New York. $4.75. xvi + 238 pp.; ill. 1951.

W. W. Coblentz of the National Bureau of Standards has had a long and distinguished career in the field of radiometry. The establishment of standards of radiation, the determination of absorption spectra in the infrared and ultraviolet portions of the spectrum, and the development of instruments for the measurement of radiations—to mention a few of his outstanding contributions—have placed all of the physical and biological sciences in Coblentz' debt. Many who depend upon the background of information he has provided are quite unaware of his profound influence, and, in view of this, an autobiography would seem singularly appropriate at this time, when the measurement of radiation in war and in peace is of the utmost importance. As a life story, however, the volume is one which, in its present form, would better have been left among the dusty files of the Bureau. Covering his life from childhood on, it is characterized by an ineptness, a heavy-handed humor, and a chip-on-the-shoulder attitude that destroy its literary value. Innuendoes and irrelevancies continually break in on the reader's train of thought, leading to a disjointedness that is most distressing. In fairness to a brilliant scientist, the publishers should never have accepted the volume for publication. The restrained statement on the dust jacket is indicative of their awareness of the undistinguished character of the book. Those who are familiar with Walter B. Cannon's *The Way of an Investigator* will be deeply disappointed in Coblentz' autobiography, which might have done for radiometry what Cannon's book has done for biology and medical physiology.

C. P. SWANSON

ALBERT EINSTEIN: PHILOSOPHER-SCIENTIST. *Volume VII in "The Library of Living Philosophers."*

Edited by Paul Arthur Schilpp. The Library of Living Philosophers, Evanston, Ill. $8.50. xvi + 781 pp. 1949.

The *Library of Living Philosophers* is based upon the curiously sensible thought that "the interminable controversies which fill the history of philosophy . . . could have been ended at once by asking the living philosopher a few searching questions." While the *Library* is in no sense intended to take the place of the major writings of great and original thinkers, the editor has in the present instance assembled an extremely interesting collection of interpretations, appreciations, and criticisms of the work of Albert Einstein. The result is a book which should be received with enthusiasm as an authoritative summary, in very general terms, of the current situation in physics, as well as a moving tribute to a genial and beloved leader, and a most invigorating introduction to modern physics. Here is a discussion of the problems of physics in which the serious beginning student may find a fabulous richness of orientation and inspiration. One may question, however, whether the poets should not dispute the right of the philosophers to claim Einstein as their own.

The volume begins with some 95 pages of autobiographical notes, written in the incomparable Einstein's original German with a concurrent English translation by Schilpp. The following quotations may indicate something of their content.

"Here I sit in order to write, at the age of 67, something like my own obituary. I am doing this not merely because Dr. Schilpp has persuaded me to do it; but because I do, in fact, believe that it is a good thing to show those who are striving along side of us, how one's own striving and searching appears to one in retrospect." At an early age, "the nothingness of the hopes and strivings which chase most men restlessly through life came to my consciousness with considerable force. Moreover, I soon discovered the cruelty of that chase, which in those years was much more carefully covered up with hypocrisy and glittering words than is the case today . . . As the first way out there was religion, which is implanted into every child by way of the traditional education machine. Thus I came to a deep religiosity, which, however, found an abrupt ending at the age of 12. Through the reading of popular scientific books I soon reached the conclusion that much in the stories of the Bible could not be true. The consequence was a positively fanatic orgy of free-thinking coupled with the impression that youth is intentionally being deceived by the state through lies; it was a crushing impression. Suspicion against every kind of authority grew out of this experience, a skeptical attitude towards the convictions which were alive in any specific social environment—an attitude which has never left me. . . ."

At the Polytechnic Institute of Zurich, "I worked

most of the time in the physics laboratory, fascinated by the direct contact with experience. I neglected mathematics to a certain extent.... My intuition in the field of mathematics was not strong enough to differentiate clearly the fundamentally important, that which is really basic, from the rest of the more or less dispensable erudition. Beyond this, however, my interest in the knowledge of nature was also unqualifiedly stronger; and it was not clear to me as a student that the approach to a more profound knowledge of the basic principles of physics is tied up with the most intricate mathematical methods.... In this field [of physics] however, I soon learned to scent out that which was able to lead to fundamentals and to turn aside from everything else, from the multitude of things which clutter up the mind and divert it from the essential. The hitch in this was, of course, the fact that one had to cram all this stuff into one's mind for the examinations, whether one liked it or not. This coercion had such a deterring effect upon me that, after I had passed the final examination, I found the consideration of any scientific problems distasteful to me for an entire year.... It is in fact, nothing short of a miracle that modern methods of education have not yet entirely strangled the holy curiosity of enquiry; for this delicate little plant, aside from stimulation, stands mainly in need of freedom; without that it goes to wreck and ruin without fail."

The autobiographical notes soon merge into fascinating comments on the history of physics. For example, classical thermodynamics is "the only physical theory of universal content concerning which I am convinced that, within the framework of the applicability of its basic concepts, it will never be overthrown (for the special attention of those who are sceptics on principle)."

"The most fascinating subject at the time that I was a student was Maxwell's theory. What made this theory appear revolutionary was the transition from forces at a distance to fields as fundamental variables. The incorporation of optics into the theory of electromagnetism, with its relation of the speed of light to the electric and magnetic absolute system of units as well as the relation of the refraction coefficient to the dielectric constant, the qualitative relation between the reflection coefficient and the metallic conductivity of the body—it was like a revelation..." And so Einstein discusses "the great service of H. A. Lorentz.... The dualism which lies in the fact that the material point in Newton's sense and the field as continuum are used as elementary concepts side by side... a second fundamental crisis, the seriousness of which was suddenly recognized due to Max Planck's investigations into heat radiation (1900).... shortly after the appearance of Planck's fundamental work, without having a substitute for classical mechanics, I could nevertheless see to what kind of consequences this law of temperature radiation leads for the photo-electric effect and for other related phenomena... All my attempts, however to adapt the theoretical foundation of physics to this knowledge failed completely. It was as if the ground had been pulled out from under one, with no firm foundation on which one could have built. That this insecure and contradictory foundation was sufficient to enable a man of Bohr's unique instinct and sensitivity to discover the major laws of the spectral lines and of the electron-shells of the atoms together with their significance for chemistry appeared like a miracle—and appears to me as a miracle even today. This is the highest form of musicality in the sphere of thought....

"... The statistical quantum theory... is the only theory at present which permits a unitary grasp of experiences concerning the quantum character of micromechanical events. This theory, on the one hand, and the theory of relativity on the other, are both considered correct in a certain sense, although their combination has resisted all efforts up to now. This is probably the reason why there exist among contemporary theoretical physicists entirely differing opinions as to how the theoretical foundation of the physics of the future will appear. Will it be a field theory; will it be in essence a statistical theory? I shall briefly indicate my own thoughts on this point..."

Following the autobiographical notes comes a series of descriptive and critical essays on the work of Albert Einstein: To Albert Einstein's Seventieth Birthday (Arnold Sommerfeld); The Scientific Work of Albert Einstein (Louis de Broglie); Presuppositions and Anticipations in Einstein's Physics (Ilse Rosenthal-Schneider); Einstein's Contributions to Quantum Theory (Wolfgang Pauli); Einstein's Statistical Theories (Max Born); The Departure from Classical Thought in Modern Physics (Walter Heitler); Discussion with Einstein on Epistemological Problems in Atomic Physics (Neils Bohr); Einstein's Conception of Reality (H. Margenau); Einstein, Mach, and Logical Positivism (P. G. Frank); The Philosophical Significance of the Theory of Relativity (Hans Reichenbach); Geometry as a Branch of Physics (H. P. Robertson); Einstein's Theories and the Operational Point of View (P. W. Bridgeman); Einstein's Theory of Knowledge (V. F. Lenzen); Einstein's Conception of Science (F. S. C. Northrop); Gravitation without General Relativity (E. A. Milne); The Cosmological Constant (G. E. Lemaitre); Modern Geometry and the Theory of Relativity (Karl Menger); General Relativity and the Structure of our Universe (L. Infeld); Inertia and Energy (Max von Laue); Scientific and Philosophical Implications of the Special Theory of Relativity (H. Dingle); A Remark about the Relationship between Relativity Theory and Idealistic Philosophy (K. Godel); The Philosophic Dialectic of the Concepts of Relativity (G. Bachelard); Einstein's Theory of Relativity Viewed from the Standpoint of Critical Realism, and

Its Significance for Philosophy (A. Wenzl); Einstein's Influence on Contemporary Philosophy (A. P. Ushenko); and Einstein's Social Philosophy (V. Hinshaw, Jr.). The book also contains a list of the writings, interviews, and speeches of Albert Einstein.

Einstein replies to a number of these authors in a section entitled Remarks to the Essays Appearing in this Collective Volume. Upon the old question "continuum versus discontinuity," Einstein has taken his position most decisively on the side of the continuum. Most contemporary physicists consider Einstein's aim as unachievable. The thoughts expressed in this book lie now in the crucible of the future, a future in which conceivably biophysics may play a relevant role. In view of the total work of Einstein, Sommerfeld reminds us of the beautiful couplet which Schiller dedicated to Columbus:

With the genius nature remains in eternal union:
What the one promises, the other certainly redeems.

EVELYN HOWARD

STUDIES HONORING TREVOR KINCAID.

Edited by Melville H. Hatch. University of Washington Press, Seattle. $2.50 (paper). iv + 140 pp. + 13 pl.; text ill. 1950

Volumes of this sort, in honor of an elder biologist and teacher, have been much more frequent in Europe than on this side of the water. The appearance of the present *Festschrift*, in honor of one who was for many decades a leader in the study of biology on the Pacific coast, may indicate that the tradition is spreading to America.

The volume contains a biography of Professor Kincaid, a list of his publications, and an impressive list of plants and animals named in his honor; An Account of the Life of Orson Bennett Johnson, a still earlier pioneer naturalist of the Pacific northwest and one of Kincaid's teachers; an account of The Young Naturalist Society (1879–1905); and the following technical papers by colleagues, former students, and other friends of Professor Kincaid: A Comparative Study of the Thyroid Follicle (Sydney E. Johnson); The Genotype and Systematic Position of *Sporadogenerina* Cushman—Foraminifera, Polymorphinidae (Don L. Frizzell); Review of Thirteen Genera of South American Fishes in the Subfamilies Cynodontinae, Hepsetinae, and Characinae, with the Description of a New *Cyriocharax* (Leonard P. Schultz); Early Life History and Larval Development of Some Puget Sound Echinoderms (Martin W. Johnson and Lelia T. Johnson); Some Monogenetic Trematodes of Puget Sound Fishes (Kelshaw Bonham); Methods for the Study and Cultivation of Protozoa (Vance Tartar); Conopisthine Spiders (Theridiidae) from Peru and Ecuador (Harriet Exline); and Some Remarks on the Blood Volume of Fish (Arthur W. Martin).

A SHORT HISTORY OF AGRICULTURE IN THE BRITISH COLONIES.

By G. B. Masefield. Oxford University Press, New York and London (printed in Great Britain). $2.50. viii + 179 pp. 1950.

This little volume, written by an authority on tropical agriculture, traces the history of agriculture in the British Colonies and emphasizes particularly the part that technical changes and modern scientific discoveries have played in its development. The discussion centers around 4 periods in agricultural history, and its scope may best be indicated by the various headings: I. The Amateurs, 1492–1660 (Agriculture at the Discovery of America; The Beginnings of Tropical Agriculture; The Post-Columbian Dispersal of Crops and Livestock; The First English Tropical Colonies). II. The Mercantile Empire, 1660–1838 (The Sugar Colonies; Africa and the East). III. Private Enterprise, 1838–1900 (Colonial Sugar Production; The Origins of Rubber Planting; Developments in Africa; The Ceylon Planting Industry in the Nineteenth Century; New Trends in the West Indies). IV. Public Service, 1900–1948 (A New Era; The Colonial Agricultural Service; Soil Conservation; Peasant Production of Cash Crops; European Settlement in Tropical Africa; Land Questions and Agriculture; The Dangers of Mono-control; Advances in Insect Control; Problems of Livestock Improvement; Rubber and the Development of Malaya; The Sugar Industry in the Twentieth Century; Commodity Restriction Schemes; The Financing of Colonial Agriculture).

ALBERT F. HILL

THE YOUNG NATURALIST

THE INSECT MAN. *A Puffin Story Book. Reprint. By Eleanor Doorly. Penguin Books, Harmondsworth, Middlesex; [Baltimore, Md.]* 35 cents (paper). 167 pp.; ill. 1949.

This is a reprinted edition of a book first published in 1936, but those who are not familiar with it have missed a rich and exciting excursion into the life of Henri Fabre, the French entomologist. It concerns the visit of some English children to the home and the locale in which Fabre lived and studied, and Miss Doorly has done much to convey the simplicity, the sincerity, and the greatness of an almost legendary figure.

WONDERS OF THE SEASHORE.

By Jacquelyn Berrill. Dodd, Mead & Co., New York. $2.50. 69 pp.; ill. 1951.

For the child who lives or vacations at the seashore, this fine book will add much to his enjoyment by open-

ing the door to the varied life to be found in the sand, in the tidepools, and on the rocks which edge the sea. Both the plants and animals of the tidal zone are considered in an understandable and stimulating manner, and the sketches of seashore life nicely complement the text. Mrs. Berrill is to be complimented on her book, which in many ways is superior to the usual nature books for children.

C. P. SWANSON

THE FIRST BOOK OF TREES.
By M. B. Cormack; pictures by Helene Carter. Franklin Watts, New York. 93 pp.; ill. 1951.

Prepared for the young reader with a bent toward natural history, this volume will provide the basic information necessary for the identification of our more common North American trees, as well as a good bit of sound botanical knowledge of the life of a tree, and its place in the economy of nature and of our nation. The excellent illustrations complement the text admirably. The book can be recommended to anyone, regardless of age, who would learn something of the larger flora about him.

C. P. SWANSON

INSECTS. *A Guide to Familiar American Insects.*
By Herbert S. Zim and Clarence Cottam; illustrated by James Gordon Irving. Simon & Schuster, New York. $1.00. 157 pp.; ill. 1951.

FLOWERS. *A Guide to Familiar American Wildflowers.*
By Herbert S. Zim and Alexander C. Martin; illustrated by Rudolf Freund. Simon & Schuster, New York. $1.00. 157 pp.; ill. 1950.

Zim and his collaborators have provided the budding naturalist with two excellent and inexpensive field guides which take in the more common insects and flowers of this country. 225 insects and 134 wildflowers are illustrated in full color, and in a detail worthy of more expensive volumes. Each species is described in somewhat meager detail as to habit and range, but the amateur will encounter little difficulty in identification if comparison is made with the illustrations. These volumes are highly recommended, although they could be improved by the inclusion of scientific names.

C. P. SWANSON

BRITISH BUTTERFLIES. *Black's Young Naturalist's Series.*
By George E. Hyde. Adam & Charles Black, London; The Macmillan Co., New York. $1.25. 96 pp. + 24 pl.; text ill. 1950.

BIRDS OF BRITAIN. *Black's Young Naturalist's Series.*
By Wilfred Willett. Adam & Charles Black, London; The Macmillan Co., New York. $1.25. 95 pp. + 24 pl.; text ill. 1950.

EGGS AND NESTS OF BRITISH BIRDS. *Black's Young Naturalist's Series.*
By Richard L. E. Ford. Adam & Charles Black, London; The Macmillan Co., New York. $1.25. 96 pp. + 24 pl. 1950.

WILD FLOWERS. *Black's Young Naturalist's Series.*
By W. R. Philipson. Adam & Charles Black, London; The Macmillan Co., New York. $1.25. 96 pp. + 24 pl.; text ill. 1950.

These 4 volumes represent the first in the Young Naturalist's Series. As an introduction to British wildlife, they go far to provide the basic knowledge which a curious youngster needs as his guide in the field, and the necessary enthusiasm to spur him on to studies of his own. The text is easy reading, and the illustrations, both colored and black-and-white, are uniformly good. Although the volumes deal only with British forms, they should interest any beginner who wishes to learn more of the living things about him.

C. P. SWANSON

BRITISH FOSSILS. *Young Naturalist's Series.*
By Duncan Forbes. Adam & Charles Black, London. 6s. 6d. 96 pp. + 23 pl.; text ill. 1951.

The beginner in paleontology will find this volume of the Young Naturalist's Series highly intriguing and informative. Some knowledge as to classification is necessary for its complete understanding, but the meaning of fossils in the evolution of organic life, the likely sources of fossil material, their approximate age, and hints for beginning a collection are ably handled in an informal and readable fashion. The illustrations will be found useful wherever one collects, and as an introduction to serious collecting, the book provides the first sound steps. It is well worth its modest price.

C. P. SWANSON

EVERY CHILD'S BOOK OF ANIMAL WONDERS.
By J. Benlley Aistrop. Roy Publishers, New York. $2.50. 172 pp. + 14 pl. 1951.

This volume, by one of the youngest members of the London Zoological Society, is sure to delight and inform boys and girls of the 10 to 14 year old group. The animals considered come from the four corners of the world, and from your own back yard. The author writes with a freshness, and a down-to-earth directness based on first hand experience that is admirable. He offers many suggestions about how to get the most out of your trip to the zoo, how to make a miniature zoo on your

window sill or in an unused greenhouse, and about many other tropics.

The organization of the book is not at all taxonomic, though nearly all the animals included are vertebrates and most of them mammals. This selection corresponds to the usual interests of the general public. Zoologists will inevitably feel that the black widow spider and the Portuguese man of war are each worth more than a brief paragraph. But perhaps this is really to suggest that the author should write a second book. The 16 chapters of this one are organized around such topics as Creatures Which Help Man, Creatures Which Hinder Man, Architects of the Animal World, Clowns and Show-offs, and Defensive Devices.

Here and there it is possible to find a slip that can be corrected in a second printing. It is a fine scheme to advise youngsters to learn some of the scientific names of their pets but a pity to call *Triturus viridescens* "Diemyctylus viridescens," a name out of good usage, to say the least, for about half a century. To say that the little lizard sold in this country as a chameleon "is not related in any way to the true chameleon" is of course a gross overstatement. Raymond Ditmars' name is sometimes misspelled. Adaptation is explained teleologically. The material on instinct is slim stuff.

An outstanding feature of the book is the series of handsome and informative full-page photographs of animals. Preeminent among these is the frontispiece, which shows a pair of black swans with 4 cygnets, *white* cygnets! Perhaps the explanation of those white cygnets may be clear to a geneticist, but they seem certain to baffle the logician. In any case, the small readers will be prepared for the famous white swan problem when they reach elementary college logic.

GAIRDNER B. MOMENT

YOUNG READERS WILD LIFE STORIES.

Edited by A. L. Furman; illustrated by Charles H. Geer. Lantern Press, New York. $2.50. 191 pp.; ill. 1951.

The eleven short stories grouped together in this volume are varied enough to interest any child aged 9–12 who delights in adventure, the outdoors, or just good reading.

YOUNG READERS' ANIMAL STORIES.

Edited by David Thomas; illustrated by Richard Osborn. Lantern Press, New York. $2.50. 189 pp.; ill. 1950.

The 10 stories included in the volume are for youngsters of ages 8 to 12, and they cover a variety of adventures in which both wild and domesticated animals figure. The large type, simple but effective illustrations, and reasonableness of the stories make this a most acceptable book.

GOLDEN HAMSTERS.

By Herbert S. Zim, illustrated by Herschel Wartik. Wm. Morrow & Co., New York. $2.00. 63 pp.; ill. 1951.

Despite the fact that the hamster has been bred in captivity only since 1930, this animal bids fair to replace the white mouse as a pet. Its laboratory usefulness has, of course, been amply proven. Herbert S. Zim discusses the hamster in his usual matter-of-fact style: phylogenetic relationships, laboratory and home care, feeding and breeding habits, developmental stages, sex differences, and possibilities as a pest if indiscriminately released. The book is a fitting companion for his previous volumes on the owls, snakes, and whales.

STRIPE. *The Story of a Chipmunk.*

By Robert M. McClung. William Morrow & Co., New York. $2.00. 48 pp.; ill. 1951.

THUNDER WINGS. *The Story of a Ruffed Grouse.*

By Olive L. Earle. William Morrow & Co., New York. $2.00. 48 pp.; ill. 1951.

Both of these small volumes maintain the high standards of story-telling, scientific accuracy, and illustration which has in the past characterized the Morrow Junior Books. The stories of both animals cover the period from birth to maturity, and each is appropriately spiced with adventures that will keep the young reader's excitement high.

THE GREAT WHALES.

By Herbert S. Zim; illustrated by James Gordon Irving. Wm. Morrow & Co., New York. $2.00. 63 pp. 1951.

It is virtually impossible to praise this little volume too highly. The illustrations by James Gordon Irving have never been surpassed and seldom equalled for combining scientific accuracy with artistic skill. On every page these superb figures tell their story with dramatic clarity. The text fully matches the illustrations. It is accurate, tremendously inclusive, in fact a masterpiece of condensation, simply put without technical terms, yet definite and informative. It is exciting from the very nature of its subject without the slightest trace of sensationalism or "over writing." How many volumes would Melville have required to say as much!

Adults should not be deceived by the large type. Anyone who has smelled the sea or read Moby Dick will want to read this. It is one aspect of science writing at its best.

GAIRDNER B. MOMENT

FROM LITTLE ACORNS. *The Story of Your Body. By Frances W. Butterfield; pictures by Dorothy M. Weiss. Renbayle House, New York.* $2.50. 158 pp.; ill. 1951.

This is a sort of textbook on human physiology written for the young folk—aged 8 to 12. It tells in a simple, factual way about the body and how it works. There are 6 chapters: It Started With an Apple (the digestive system); Air Conditioned (the respiratory system); Pumping Station (the circulatory system); Frame-up (the skeleton and musculature); Switchboard (the central nervous system, eye, and ear); and Tall Oaks From Little Acorns Grow (the reproductive system). Numerous illustrations accompany the text. This moderately heavy reading fare is woven into a story about David and Judy Jones who visit their grandfather, a physician, for a spring vacation. Their excursion into the machinery of the body are presented mainly by dialogue of the question-and-answer type.

The fictional part of the book is apt to strike adults as being a little preposterous, but it is probably the sort of story that will appeal to youngsters. The biological material is well-selected, accurate, and skillfully presented. Parents will probably be most concerned about the last chapter. This discusses the sexual organs, reproduction, and birth in a direct, frank manner, and tells the reader more than most parents ever tell their children about these matters. It is a thoroughly sensible presentation, much to be preferred to the usual sources from which most children have to get their sexual information, or misinformation. I, for one, shall have no hesitancy in recommending it to my children as soon as they are old enough to understand the words.

A. CHAPANIS

FUNDAMENTAL ACTIVITIES IN GENERAL SCIENCE. *A Workshop and Laboratory Manual for Use With Any Textbook. By Bernard Auerbach and Frank Fochl; edited by Carl Ecklund and Joseph E. Johnston. Republic Book Co., New York.* $1.00 (paper). xiv + 334 pp.; ill. 1949.

This well-organized laboratory manual and workbook is keyed for use with any one of 5 widely used textbooks of high school general science courses. It contains 18 units, of which 6 deal specifically with biological subject matter: Living Things—Flora and Fauna; Our Foods and How We Use Them; Other Systems of the Human Body; Man's Health and Safety; The Problem of Disease; and Our Natural Resources and their Conservation. The carefully prepared exercises live up to the claim of the manual's title: they are truthfully "fundamental." The outlined work should interest and stimulate the beginners in science who use it.

BENTLEY GLASS

ECOLOGY AND NATURAL HISTORY

THE NATURE-LOVER'S HANDBOOK. *By B. Melville Nicholas. Nicholson & Watson, London.* 15s. 135 pp. + 32 pl. 1950.

The ability to observe keenly and to write well is given only to a few individuals. B. Melville Nicholas is one of this chosen group. His wanderings over the English countryside have enabled him to see at first hand the host of species which engages only the eye of the patient, quiet observer; and his gift of descriptive expression carries the reader effortlessly along with him. The writings follow no formal plan, but rather wander in easy fashion with the author: on the moors and marshes, by the sea, along the hedgerows, and among the hills. The result is an enjoyable evening's reading to which, however, one will want to return frequently. The many photographs are excellent, but unfortunately are distributed throughout the book with little relationship to the text.

C. P. SWANSON

OUR COUNTRY'S NATIONAL PARKS. *Two Volumes. Mid-Century Edition. By Irving Robert Melbo. Bobbs-Merrill Co., Indianapolis and New York.* Vol. I: $3.50; Vol. II: $3.00. Vol. I: xii + 284 pp.; ill. Vol. II: xii + 244 pp.; ill. 1950.

Our 28 national parks, covering some 20 millions of acres, preserve much of what remains of our country's natural beauty in all its primitive splendor. Infinitely varied, and in many instances beautiful beyond description, they have become recognized as the great vacation areas for those who would seek the out-of-doors to enjoy and marvel at nature at its undisturbed best. Because of the value of our system of parks, and because of the constant danger of their loss through encroachment, destruction, and neglect, these volumes are addressed to the young people of our nation in order to tell them of the history, the beauty, and the place of the parks in our national life. Liberally illustrated with good photographs and maps, each park is fully described, good use being made of anecdotal material. I. H. Melbo is to be complimented on his excellent job.

C. P. SWANSON

OUR EASTERN PLAYGROUNDS. *A Guide to the National and State Parks and Forests of our Eastern Seaboard. By Anthony F. Merrill. Whittlesey House, McGraw-Hill Book Co., New York, London, and Toronto.* $3.75. xii + 353 pp. + 8 pl. text ill. 1950.

This book is principally a listing, by states, of the national and state recreational areas found in the eastern

United States. The facilities available are given in some detail, thus providing a serviceable guide for camper and vacationer.

CLIMBS IN THE CANADIAN ROCKIES.

By Frank S. Smythe. W. W. Norton & Co., New York. $4.50. x + 260 pp. + 37 pl.; text ill. 1951.

In this, his last book, Smythe, a professional mountain climber, tells of his experiences in the Canadian Rockies. Several of the peaks he climbed had never been scaled before, and he was the first man to explore with thoroughness the Lloyd George Mountain Region in British Columbia. Smythe's adventures make fascinating reading and his descriptions of the mountains, forests, and wildlife of that region should interest outdoorsmen, nature lovers, and mountaineers alike. The book is beautifully illustrated with photographs by the author.

A. CHAPANIS

THE BACKGROUND OF PLANT ECOLOGY. *A Translation from the German "The Plant Life of the Danube Basin," by Anton Kerner (1863).*

By Henry S. Conard. Iowa State College Press, Ames. $5.00. x + 238 pp. 1951.

This charming study of the vegetation of the historic Danube basin, *Das Pflanzenleben der Donauländer*, by Anton Kerner von Marilaun, has been carefully and ably translated for the first time. It is far more than a delightful account of the plants of that region, for Kerner dealt with many fundamentals of plant ecology. He laid the foundations, too, of phytosociology in describing the social groupings of plants and the necessity for adequate nomenclature of communities. Although generally overlooked by American ecologists, Kerner described the principles of plant succession, not only of the hydrosere, but also of the sand plains of the Pannonian lowlands and of various forest and heath communities. His observations of the effects on forests of grazing, reckless cutting of the timber, and fire are as pertinent today as in 1863. Moreover, Kerner dealt with the complex of interrelationships between climate, slope, elevation, soil, and vegetation in a fashion which reveals clearly the depths of his broad understanding of the interplay of these factors of the environment.

The reader of Conard's translation will find Kerner's descriptions set forth in vivid, lyrical prose. One example will suffice: "At the head of a motley baggage train comes now the 'Orphan Maidenhair.' Quickly and courageously it scales the walls and crosses the moats of the sandhills and finally mounts there its white floating banners triumphantly as a sign of the victory which the Plant World has wrung from the fleeting sand" (p. 79). Teleological though it is, the description is as definite scientifically as it is imaginatively phrased.

Personal anecdotes of experiences in travelling through the region further enliven the reading. Attractive typography, the rarity of errors, and a useful index each add to the value of the book. It deserves to be read by all who profess an interest in plant ecology.

W. B. DREW

THE TRIUMPH OF THE TREE.

By John Stewart Collis. Jonathan Cape, London. 10s. 6d. 254 pp. 1950.

This book represents another eloquent effort to impress upon man's consciousness that in spite of his unique ability to think and speak and manipulate his prehensile thumbs, he has still considerable to learn about the art of living in the world of nature. J. S. Collis' book traces the history of man as reflected in his attitude toward the trees. At first, when he was essentially a hunter, he feared them and sought to placate them with gifts and worship. Later, as man turned to an agrarian existence, he was compelled to clear land; but his persisting reverence (or fear) of the trees kept deforestation within reasonable limits. Finally, under impetus of the scientific era, came the idea of the "conquest of nature." The ruthless destruction of forests which followed, with all the attendant ills resulting from this unbalancing of natural processes, has at last awakened man to the realization that his pagan ancestors were right. If he is to triumph, so must the trees.

SCOTT S. PAULEY

CLIMATE IN EVERYDAY LIFE.

By C. E. P. Brooks. Philosophical Library, New York. $4.75. 314 pp. 1951.

Almost gone are the spacious days in which a young student could dedicate a portion of his time to mental rambles in the company of his favorite professor, pursuing the flight of intellectual fancy within the bounds of the accumulated wisdom, experience, insight, or flair of the older man. Brooks has been tempted to carry this process into the machine age by means of the printed word. With his international reputation as a scholar who is concerned with much more than the mechanical routine of the meteorological profession, much might have been expected of his endeavors. Indeed, those parts of his book which deal with matters in which he himself has practical experience, or in which he has had the opportunity to test his hypotheses against the mass of evidence, will maintain his reputation and do something to preserve the master-pupil relationship in this age of impersonal abstracts and summaries. Unfortunately, he has succumbed to the

temptation of imposing a systematic arrangement upon what are essentially random viewpoints, and of filling in the lacunae with material close at hand. As a result, he not only loses spontaneity, but jeopardizes his reputation for critical and careful judgment.

It is particularly unfortunate that much of the application he seeks to make of climatology to biology suffers from this defect. This is par cularly true in respect of man. Brooks has apparently adopted whole, and without question, what in this country would be called the environmentalist doctrine. "The efficiency of any group of people, such as a school or college, a body of professional men, or the personnel of a Government department, factory or office is bound up with the climatic conditions in which they work and live." With whole-hearted enthusiasm he declares, with obvious conviction, that "the climate of Britain and especially of south-east England, is, on the whole, ideal for most forms of human activity"; whereas in Eastern Europe and Siberia (Bulgaria to Archangel and Vladivostok) "all life is completely dominated by climate." He thus puts himself at odds simultaneously with history, the authors of travel bulletins from Quebec to California, those who profess some fear of developments behind the Iron Curtain, and the reviewer, who feels only depressed by the "ideal" climate of southeast England. That climate is an important factor in the unstable, shifting equilibrium we call life, cannot be gainsaid; but it is only one factor, it is seldom superior to man's adaptiveness, and the significance it acquires is usually permissive rather than mandatory. With this unquestioned assumption of the superiority of one's ancestral climate goes the implication that climates unsuitable to "whites" may be quite all right for those not so colored—though it is never clear whether this makes the colored inferior or superior. In short, the author has apparently not realized that the fumbling, prejudice-ridden speculations on human climatology which marked the earlier years of this century must now be replaced by concepts derived through the experimental approach, repeatedly tested by more adequate enquiries and emancipated from the restrictions of a race-dominant culture. Yet it is the meteorologists who provide much of the evidence, many of the techniques, and not a little of the interest.

As is only to be expected, the failure to appreciate the newer approaches to the problem of human adaptation to climatic conditions leads to numerous inadequacies, and sometimes errors, in the detailed statements connected therewith. Sun-stroke is no longer considered distinct from heat stroke; the thermal diffusivity of walls needs to be considered as well as their conductivity; the katathermometer is now seldom used as a measure of atmospheric acceptability; better information is available on window and roof design; the "restless energy" of North American people in fact shows little regard for the local climate; the lack of oxygen may produce anoxia, but hardly anemia; factory work is seldom regarded as uneconomic in summer in the U.S.A. Yet there is much here that is good, much that is stimulating. The book can be thoroughly recommended to the cautious reader of critical and independent mind; but it should on no account be prescribed as a textbook for the routine, poorly trained, or uncritical student.

DOUGLAS H. K. LEE

THE SEA AROUND US.

By Rachel L. Carson; drawings by Katherine L. Howe. Oxford University Press, New York. $3.50. viii + 230 pp.; ill. 1951.

An amazing amount and variety of information about the physical oceanography of the seas has been summarized in this book, with the pros and cons of debatable theories adequately presented. As a book for the general reader it leaves little, except perhaps a few more illustrations, to be desired. Errors are few (fewer, it might be noted, than in the *New Yorker* version which preceded formal book publication), and of a relatively minor nature. The style in which it is written is generally pleasing and well-placed, although the literal-minded, as opposed to literary-minded, may balk now and then at the occasional use of "ever" and "only" to add emphasis to a statement, for example, "The first European ever to sail across the wide Pacific . . ." Rachel Carson will also have trouble with the die-hard disciples of Ignatius Donnelly, like everyone who tries to be rational about Atlantis, but she will have many readers who will be grateful to her for a good, thorough popularization of a perennially favorite subject. The key to this is of course her enthusiastic interest in the subject herself, which she manages to convey as freshly at the end as at the beginning of the book.

JOEL W. HEDGPETH

DRAGONS IN AMBER. *Further Adventures of a Romantic Naturalist.*

By Willy Ley. Viking Press, New York. $3.75. viii + 328 pp.; ill. 1951.

Whether writing in the field of jet propulsion, in which he is an expert, or in the field of biology, in which he is, in his own words, a "romantic naturalist," Willy Ley has demonstrated an ability which places him in the front ranks of those scientists who are willing to take the time to write for the intelligent public. His first book in "romantic" biology, *The Lungfish, the Dodo, and the Unicorn*, brought rare reading pleasure to a wide audience. *Dragons in Amber* provides a fitting companion volume. In both books, humor, lightness, and readability are maintained without sacrifice of scientific accuracy.

Dragons in Amber is divided into three sections. The

first, Records in Stone, tells the stories of Baltic amber, of the discovery of the hairy mammoth, and of the detective work which finally solved the identity of the fossils *Chirotherium* and *Icthyosaurus*. Part Two, entitled The Last of their Kind, tells of Père David's deer (the milu), the giant panda, and the New Zealand takahe, animals which in their native habitats are extinct or nearing extinction, and of the ginkgo, the redwoods, and the cycads, plants which despite their ancient nature still hold their own in the company of their more biologically efficient descendants. Part Three deals with the wanderers of the earth. Excellent accounts are given of the wanderings of the eel, the history of the camel which was typically American in prehistoric times, the migrations of plants and animals which have invaded new lands, and the fascinating chronicle of the death of an island (Krakatoa) by volcanic explosion and its subsequent colonization by adventive flora and fauna.

The smooth flow of the stories, the wealth of anecdotes which humanize the scientist by exposing some of his errors and foibles, and the evident pleasure the author must have gained in putting his thoughts on paper, will tend to make the reader forget or overlook the enormous amount of detailed sifting of data which must have preceded the actual writing. Biology is fortunate in having so gifted a pen at its disposal.

C. P. SWANSON

UNTRUTHS ABOUT ANIMALS. *A Cyclopedia of Animal Fallacies.*

By Orville A. Lindquist. Dietz Press, Richmond, Virginia. $1.50. ii + 117 pp. 1950.

As the subtitle indicates, this book is a cyclopedia of animal fallacies, the items being arranged alphabetically by animals. A, the albatross is not extinct; and Z, the zebra can be trained, both contrary to popular belief. One thing the zoologist can learn from this book is the great number of odd fallacies that apparently exist. I for one never suspected that people believe that the grizzly is gregarious or that elephants abhor tobacco (as a matter of fact, I never even knew that elephants like tobacco). A reference is provided for each myth exploded.

HENRI C. SEIBERT

THE FLAMINGOS OF THE CAMARGUE.

By Étienne Gallet. Macmillan Co., New York; Basil Blackwell, Oxford. $3.00. 127 pp.; ill. 1951.

The German translation of this book has been previously reviewed in these pages (*Q.R.B.*, 24: 142. 1949) and so need not be repeated here. The present English version is identical in size and even in number of pages. Although the paper is seemingly of inferior quality, the plates are better reproduced.

HENRI C. SEIBERT

NATURE'S WAYS. *How Nature Takes Care of its Own.*

By Roy Chapman Andrews; illustrated by Andre Durenceau and others. Crown Publishers, New York. $3.75. 206 pp.; ill. 1951.

Roy Chapman Andrews needs no introduction as an observing naturalist and a skilful writer whose treks have led him to the remote places of the world. More intimately than most biologists, he knows his animals at home, and he has seen how marvelously the animal fits into its own peculiar habitat, sometimes in a manner that borders on the incredible. The survival of the fittest has been attained in innumerable ways, by exploiting, in an adaptive fashion, those features which render an animal capable of holding its own in the midst of competition. The fact that many animals would soon become extinct in a new environment—witness the dodo—is proof enough of the compatibility of the organism with its surroundings, and of the fact that evolution proceeds by the conversion of natural accidents (mutations) into orderly mechanisms of survival. These mechanisms depend upon the development of features—anatomical, physiological, mental—which more than counterbalance the factors that cause depletion in the ranks. Camouflage and mimicry, speed and strength, keen sight and smell, defensive and offensive devices, food and reproductive habits, singly and in combination, are the means employed. It is these with which the author concerns himself, and the story of each animal is told in a brief but well-integrated manner, with accompanying illustrative material lavishly used. The result is a rare and fascinating volume, which is destined to take its place along with the best of our natural history writings.

C. P. SWANSON

WILD ANIMALS IN BRITAIN—*Mammals, Reptiles and Amphibians.*

By Oliver G. Pike. Macmillan & Co., London. 18s.; $3.75. xii + 231 pp. + 8 pl.; text ill. 1950.

The writers of bird books had better look to their laurels or else the beast book writers will supplant them. The present is the third, at least, to emanate recently from England. The wild animals refer to the mammals, reptiles, and amphibians of Great Britain. Each animal is described and its general habits are discussed. Whereas Sandars' *Beast Book* (see *Q.R.B.*, 26: 301. 1951) stressed identification, the present one emphasizes life histories. An attempt at identification is made, but many mammals, especially the rodents, are not easily identified without some technical knowledge, and it is doubtful whether such descriptions as those given here will be of great value. Tooth formulae are provided, but this is seldom helpful in differentiating species. Although subspecies are included in the list, they might properly have been omitted in a book of this nature. With reference to the Skomer vole, 2 other

species of voles are mentioned, although they are referred to as subspecies. The accounts of the life histories are interesting but certainly not always critical. Many tales that the writer has picked up at second-hand are related in good faith—thus the mole is said to feed at 7 A.M., 11 A.M., 3 P.M., and 7 P.M. (G.M.T.)—sic! Other accounts are partly discredited, some rather hesitatingly, but too many are not. A few oversights appear: the brown rat is called *Rattus rattus*, but the roof rat and the alexandrine rat are listed as races of *Epimys rattus*. There is an index to scientific names (which could have been better proofread) and a general index. Photographs and 7 color plates illustrate practically all the species discussed. In spite of the adverse comment above, there is nevertheless much sound information in the book, including original observations, about these relatively poorly known groups of animals. The book should have a wide popular appeal.

HENRI C. SEIBERT

WILD ANIMALS IN CAPTIVITY.

By H. Hediger; translated by Z. Sircom; foreword by Edward Hindle. Butterworths Scientific Publications, London; [Academic Press, New York]. $6.00. x + 207 pp. + 16 pl. 1950.

There have been dozens of books with the same or a similar title, dealing with zoological gardens, describing adventures with wild animals before and after their capture, and recording entertaining, but mostly amateurish, random observations on the behavior and the needs of captive animals. This extensive literature has stimulated popular interest in zoos and has gradually contributed a good deal to our still very inadequate knowledge of the essential requirements for the successful survival of animals in captivity. The present volume by the director of the splendid zoological garden in Basel represents the first, outstanding attempt to supply a systematic, scientific account of the innumerable and involved problems connected with the efficient management of a modern zoo. As such, this work will be of great interest to students of animal behavior and ecology and, at the same time, is a challenge to those in charge of our very expensive "animal shows," who are more concerned about their public than their animals and who boast of the numbers of visitors while ignoring the mortality rate among their captives. Hediger states bluntly and with full justification that "consideration for the public should never be allowed to jeopardize the well being of the animal." With a few laudable exceptions, our American zoos have been hesitant to adopt this principle, which ought to be a matter of course for humane, as well as financial, reasons, and which would prevent much of the abnormal animal behavior exhibited with careless ignorance in old-fashioned zoos. An expert landscape gardener, an architect, a veterinary, and a pathologist should be on the staff of every progressive zoo, but there is even greater need for a competent psychologist.

By making use of a great many sound observations on animal behavior, gathered from a widely scattered literature, and of his own numerous relevant studies, the author discusses in detail the physiological and psychological territorial requirements of animals, their sociological relationships, their mating- and breeding-patterns, their needs regarding climatic conditions, food, exercise, companionship, etc., and especially, how captivity can approach or best compromise with natural conditions. Thus one finds in this pioneering textbook a wealth of fascinating information on animals ranging from invertebrates to primates.

The limited space available in captivity is rarely such a hardship as it is popularly regarded, provided the arrangements of confinement correspond to the species' ideas of a "home," there are no uncongenial neighbors or cage-mates, and feeding and cage-cleaning do not conflict in method or time with the animal's natural habits. These simple rules actually presuppose a vast amount of detailed knowledge and painstaking observation. Besides the obviously important enemy-prey relationships between animals, there are equally vital and deeply entrenched relationships based on "biological rank" and "social rank." The former ranks are found among species similar to each other, and which are competitors in nature; and the latter exist within a species and may or may not be dependent upon physical prowess. Ignorance of these widely different and highly interesting conditions is bound to lead to tragedies and needless loss among captive animals.

In nature most animals really do not enjoy full freedom, but are tied to a definite territory, are inhibited by social rank, are in constant fear of predators, are exposed to periods of famine, and frequently are sexually frustrated, while disease and accidents are surprisingly prevalent. On the other hand, in a modern zoo under competent care most animals actually reach an older age than in their natural habitat and grow and breed successfully once all of their natural needs have been discovered and provided for, including all psychological ones. Thus Hediger tries to convince his readers that it is a privileged animal which is caught and allowed to live in his zoo. At any rate, this stimulating and informative volume will be of the greatest help to all those responsible for the welfare of wild animals in captivity and for showing how these animals normally behave.

A. H. SCHULTZ

THE ELK OF NORTH AMERICA.

By Olaus J. Murie. Stackpole Co., Harrisburg, Pennsylvania, and Wildlife Management Institute, Washington, D. C. $6.50. x + 376 pp. + 30 pl.; text ill. 1951.

This is one of the series of monographs on large North American mammals published by the Wildlife Management Institute and its nominal predecessor, the American Wildlife Institute. Each of the monographs published to date was prepared by an outstanding naturalist. This one is no exception. Olaus Murie is the leading authority on the North American elk. The high quality and thoroughness of this report bespeaks many years of first-hand experience with the animal in its native environment. Most aspects of the life history of the animal are treated in the book, under section heads as follows: Habitat, Migration, Physical Characters, Reproduction, Natural Enemies, Accidental Deaths, Parasites, Disease, Food Habits, Elk Habits, The Elk Population. Three chapters are devoted to the past and present distribution of the species and subspecies of North American elk. There is a chapter on hunting and another on management. This chapter will be of special interest to those who administer wildlife. It should be required reading for each student of wildlife management, in my opinion. The bibliography consists of some 450 titles. Numerous lucid, line drawings by the author are decided assets. Many of the 29 halftones, however, are not up to the quality of the rest of the book. This volume is a significant contribution to the knowledge of North American mammals. It will be a useful item in the library of mammalogists, wildlife administrators and technicians, students, and sportsmen.

E. T. HOOPER

EVOLUTION

ENTWICKLUNGSGESCHICHTE DES PFLANZENREICHES. *Sammlung Göschen, Band 1137.*

By Hans Heil. Walterde Gruyter & Co., Berlin. DM 2.40 (paper). 138 pp.; ill. 1950.

This compact little book is one of the best botanical contributions to the familiar Göschen series. Despite the limited space available for the purpose, the author has managed to crowd into it the most essential facts pertaining to evolution in plants and the best current interpretations of these. The illustrations, though small and printed on somewhat inferior post-war stock, are well chosen and conveniently grouped. The four parts of the book deal with the following major topics: 1) the interrelations among living plants (or principles and examples of evolution derived from living plants); 2) the paleobotanical record (largest part); 3) dicta relative to evolution in plants; and 4) systems of classification, phylogenetic trees, etc. A list of the sources from which the illustrations were taken, a short bibliography, and an index to scientific terms and plant names are appended. Fig. 93 (p. 125) represents a noteworthy feature, namely, a modified version of Zimmermann's phylogenetic tree of the plant kingdom in which the ordinate represents geological time and the abscissa shows numbers of different cell types present in the groups listed in this diagram. Early vascular plants are credited with 18 to 20 cell types, whereas the Angiospermales [sic] are indicated as having 74 to 76 different kinds of cells. Unlike other schemes of this kind, this phylogenetic tree is based on statistical data and therefore regarded as more objective. All in all, *Entwicklungsgeschichte des Pflanzenreiches* is a timely and well balanced summary of evolution in plants and, as such, a commendable addition to the scanty literature in this field of botany.

THEODOR JUST

REVISION OF THE FAMILIES AND GENERA OF THE DEVONIAN TETRACORALS. *The Geological Society of America Memoir 40.*

By Edwin C. Stumm. The Geological Society of America, New York. $2.00. viii + 92 pp. + 25 pl. 1949.

The classification of the so-called tetracorals, the forerunners of the Madreporaria, is a very controversial matter. The few families once used by Zittel no longer suffice to cover the huge material added since his day. The several later classifications, however, are not satisfactory nor easily workable. Hence the author has undertaken the difficult task of establishing a new taxonomy for at least one part of the group, the Devonian tetracorals. He has thus achieved work of outstanding value, indispensable to all students of fossil corals. His classification of Devonian tetracorals, comprising 16 families and 18 subfamilies, is as follows:

1) Petraiidae De Kon.
2) Hadrophyllidae n. fam.
3) Metriophyllidae Hill
4) Syringaxonidae Hill
5) Zaphrentidae Edw. & H.
6) Acrophyllidae n. fam.
7) Halliidae Chapm.
   - Subfamily Halliinae
   - Subfamily Papiliophyllinae n. subfam.
8) Bethanyphyllidae n. fam.
   - Subfamily Bethanyphyllinae
   - Subfamily Blothrophyllinae n. subfam.
9) Acanthophyllidae Hill
10) Leptoinophyllidae n. name
    - Subfamily Leptoinophyllinae
    - Subfamily Grypophyllinae n. subfam.
    - Subfamily Stringophyllinae Wdkd.
11) Columnariidae Rom.
    - Subfamily Columnariinae
    - Subfamily Spongophyllinae Dyb.
12) Disphyllidae Hill
    - Subfamily Disphyllinae
    - Subfamily Pachyphyllinae n. subfam.
    - Subfamily Eridophyllinae n. name
13) Cystiphylloidae n. name
    - Subfamily Cystiphylloinae
    - Subfamily Arcophyllinae Mark.
14) Digonophyllidae Wdkd.
    - Subfamily Digonophyllinae
    - Subfamily Zonophyllinae Wdkd.
15) Chonophyllidae Holmes
    - Subfamily Chonophyllinae
    - Subfamily Pseudamplexinae n. subfam.
16) Calceolidae Ldstr.

All these families and subfamilies are described, as well as the 127 genera included in them. Ten of these

genera are new; 39 additional genera are placed in synonymy. The original figures of the genotype species of each genus, including those considered synonymous, are reproduced and partly supplemented by additional figures that clarify the internal structure of those species. In one or another instance one may disagree with the author, but in any case he has laid an important foundation. Unfortunately, several European papers which have appeared in the last few years have escaped the attention of the author.

OTTO H. SCHINDEWOLF

POLYCHAETE ANNELIDS FROM THE DEVONIAN OF PARANÁ, BRAZIL. *Bull. amer. Paleontol., Vol. 33, Number 134.*

By Frederico Waldemar Lange. Paleontological Research Institution, Ithaca, N. Y. $2.50 (paper). 104 pp. + 16 pl.; text ill. 1949.

This detailed monograph is the English edition of a paper originally published in 1947 in the Portuguese language (*Arquivos do Museu Paranaense*, vol. 6, Curitiba, Brazil). In the Lower Devonian Ponta Grossa shale of the State of Paraná (Brazil), the author succeeded by painstaking work in finding hundreds of dissociated scolecodonts (parts of annelid jaws) and additionally several complete jaw apparatuses, with all the maxillary plates and the mandibles preserved in their natural positions. These comprise one pair of ventral mandibles and the dorsal maxillary assemblage consisting of one asymmetrical pair each of carriers, forceps, dental plates, and paragnaths, plus one unpaired piece. These elements show considerable individual variation, partly due to changes in the succeeding ontogenetic stages and partly to slight differences in fossilization processes. Because, however, there are complete intergradations between the various assemblages and their individual parts, the author is led to the conclusion that all the remains belong to 1 species only, which after careful comparison with dissected recent and other fossil material is regarded as being new and as representing a new genus: *Paulinites paranaensis* Lange, 1947. It belongs to the superfamily Eunicea, but since there are differences from any of its families so far known, a new family Paulinitidae is erected.

The paper is of outstanding value, inasmuch as well-preserved fossil annelid remains are extremely rare and because it was possible for the first time to compare complete fossil jaws with those of recent forms in an exact morphologic and taxonomic manner.

OTTO H. SCHINDEWOLF

MAQUOKETA BRACHIOPODA OF IOWA. *The Geological Society of America Memoir 42.*

By Y. Wang. The Geological Society of America, New York. $1.40. viii + 55 pp. + 12 pl. 1949.

The Maquoketa shale, widely distributed in the Mississippi valley and in northeastern Iowa, belongs to the Upper Ordovician. Its brachiopod fauna, including 22 genera and 60 species, is described in this monograph. Five of these genera represent the Inarticulata; the rest belong to the Articulata and, without separation into families, are merely grouped as impunctate, pseudopunctate, and punctate forms. Six genera are considered new: *Lepidocyclus, Hypsiptycha, Thaerodonta, Tetraphalerella, Megamyonia*, and *Diceromyonia*. About 25 new species are erected. The accompanying plates are splendidly reproduced.

OTTO H. SCHINDEWOLF

AMERICAN PERMIAN NAUTILOIDS. *The Geological Society of America Memoir 41.*

By A. K. Miller and Walter Youngquist. The Geological Society of America, New York. $3.60. viii + 218 pp. + 59 pl.; text ill. 1949.

Nautiloids are widely distributed in the marine Permian, especially of western United States, but little attention has been paid to them in contrast to the fairly well studied ammonoids. Thus the present authors fill a gap by this important monograph, which will be highly appreciated by all working on fossil cephalopods. Altogether nearly a hundred species of Permian nautiloids are described. They are grouped into 9 families: (1) the Pseudorthoceratidae with *Pseudorthoceras* and *Mooreoceras*, (2) the Orthocerotidae with *Michelinoceras* and *Bitauniceras*, (3) the Bactritidae with *Bactrites*, (4) the Koninckioceratidae with *Koninckioceras, Knightoceras*, and *Endolobus*, (5) the Domatoceratidae n. fam. with *Domatoceras, Stearoceras, Titanoceras*, and *Stenopoceras*, (6) the Tainoceratidae with *Tainoceras, Aulametacoceras, Temnocheilus, Foordiceras, Metacoceras*, and *Cooperoceras*, (7) the Liroceratidae n. nom. (for Coloceratidae) with *Liroceras* and *Coelogasteroceras*, (8) the Ephippioceratidae n. fam. with *Ephippioceras*, and (9) the Solenochilidae with *Solenochilus*. The first of these families is placed in the suborder Cyrtochoanites; all the others belong to the Orthochoanites. No attempt is made in this paper to revise Hyatt's scheme of classification, although the authors recognize its many weaknesses. A later general study is announced in which the evolution of Late Paleozoic nautiloids and their interrelationships will be discussed. The descriptions are most careful and the plates splendid, as is always the case with these authors.

OTTO H. SCHINDEWOLF

GEOGRAPHIC VARIATION AND THE SPECIES PROBLEM IN THE SHORE-BIRD GENUS LIMNODROMUS. *University*

of California Publications in Zoölogy, Vol. 50, No. 1. By Frank A. Pitelka. University of California Press, Berkeley and Los Angeles. $2.00 (paper). iv + 107 pp.; 10 pl. 1950.

One of the most puzzling avian taxonomic problems has concerned the dowitchers, a group of shorebirds which have variously been regarded as one species, including a long-billed western form and a short-billed eastern, or at times as 2 distinct species. The discovery of short-billed dowitchers along the Pacific coast and the occurrence of long-billed specimens in the East have increased the confusion. The present monograph does much to clear up the problem. From a series of 2908 specimens, the writer concludes that 2 species exist, a long-billed, long-legged, short-winged *Limnodromus scolopaceus*, and a relatively short-billed, short-legged, and long-winged *L. griseus*. The former breeds in northern and western Alaska, the latter in southern Alaska, interior Canada, and probably Ungava. In addition, *L. griseus* possesses a transcontinental cline in size, the larger extreme in Alaska, the smaller in eastern Canada. Differences in ventral spotting and color tones also occur. For these reasons, three geographic races are recognized, *L. g. griseus* of eastern Canada (breeding area unknown, probably Ungava), *L. g. hendersoni* of the interior, and *L. g. caurinus* of southern Alaska. The last is a race newly described in this paper. Since *L. scolopaceus* breeds in northern Alaska and its range does not overlap that of *L. griseus*, the question is raised why the former should not be considered as another, allopatric race of the latter. Evidence is given to show that the discreteness of the two is maintained not only in mensural characters (no intermediates have been found) but also in color tone and pattern, in sexual dimorphosm of mensural characters (much more pronounced in *L. scolopaceus*), in the rate and extent of postjuvenal molt, in prenuptial molt, in geographical distribution (especially the wintering range), and in the period of fall migration. All of these assertions are supported by statistically treated, tabulated material, detailed descriptions of molt, and complete appendices on migration and distribution records.

HENRI C. SEIBERT

GENETICS AND CYTOLOGY

GENETICS. *A Survey of the Principles of Heredity. By A. M. Winchester. Houghton Mifflin Co., Boston.* $5.00. xii + 371 pp.; ill. 1951.

The rapidly increasing number of genetics courses offered in college curricula reflects the growing recognition of the importance of the principles of heredity in our modern society. Concurrent with the rising popularity of genetics there have appeared new textbooks designed for teaching this fascinating subject. Two or 3 of these have dominated the field in popularity and adoptions throughout the country, and have gone through several editions. This newest textbook, written for elementary courses in genetics, gives promise of taking its place among the leaders.

The beautifully clear, concise style of writing and the splendid collection of photographs, drawings, and diagrams which illustrate the topics discussed are bound to have great "student appeal" as well as call forth favorable reactions from the instructors. The author states: "The material is presented with the frank intent of arousing the interest of the student and of maintaining it throughout." It appears that he has been eminently successful in accomplishing this aim. He has done it partly through emphasis upon human heredity, but chiefly by means of the pedagogically sound method of leading the reader from specific examples to general principles.

The book is intended to be used in basic courses designed for students of varied interests and thus attempts a comprehensive coverage of the subject of heredity. To this end the topics and materials have been wisely chosen, from the exposure of false concepts of heredity and the refutation of old wive's tales to the discussion of man's survival in an atomic age and the evaluation of proposed solutions of problems of eugenics.

A brief but meaty historical sketch, including excellent portraits of leading contributors to the science, such as Darwin, DeVries, Mendel, Wilson, and Morgan, presents the background of modern genetics.

Although the author stresses the concept that genetics is a quantitative subject dealing with ratios, measurements, frequencies, etc., he keeps the actual mathematics to the minimum compatible with an understanding of the principles. His treatment of probability and related material is very simple and lucid.

The biochemical aspects of genetics, discussed very briefly in the chapter on the Nature of Genes and their Actions, seem to receive too little emphasis. Gene mutations fare much better, being covered in 2 longer chapters dealing with their nature, frequencies, methods of detection, artificial induction, etc. It is a matter of some surprise, however, to find that the Muller-5 technique of detecting sex-linked visible and lethal mutations has been omitted, since it has such obvious advantages over the ClB method.

Relatively few errors have slipped by the author and editors, but a few deserve specific mention. The statement (p. 44) that bacteria have no definite nucleus is outdated. The example (p. 81) of a cross between White Plymouth Rock and White Leghorn chickens is stated to be a typical example of dominant epistasis, whereas it is a combination of dominant and recessive epistasis. A few minor slips in fact or in the use of symbols may also be noted.

An excellent selection of problems at the end of each chapter, a list of selected references, and a carefully

compiled index constitute useful features of the textbook.

GEORGE H. MICKEY

THE MEASUREMENT OF LINKAGE IN HEREDITY. *Second Edition.*

By K. Mather. John Wiley & Sons, New York; Methuen & Co., London. $1.75. x + 149 pp. 1951.

Besides corrections, the subject matter of the First Edition (*Q.R.B.*, 14: 70. 1939) has been enlarged by the addition of a section on Fisher's scoring method for use in testing and estimating linkage, and a very useful chapter on The Estimation of Gene Frequencies, such as those for the blood groups in human populations, by the method of maximum likelihood.

STUDIO DEI GEMELLI.

By Luigi Gedda. Edizioni Orizzonte Medico, Rome. 15000 lire. XV + 1386 pp.; ill. 1951.

At last a comprehensive book dealing with all important aspects of twinning and the twin method of research is available. Gedda's *Studio dei Gemelli* far surpasses in scope anything that has previously been written on the subject. A truly magnificent book, beautifully and appropriately illustrated in both black-and-white and color, and carrying a bibliography of 7304 titles, it constitutes a veritable encyclopedia on twins.

The first chapter gives an interesting account of twins in mythology and art. Chapter Two provides an historical sketch of the development of appreciation for the value of twins as research material. Mention is made of organizations of twins and of scientists in various countries who have been and are actively engaged in research dealing with twins. This is followed by a chapter devoted to a review of the literature on twins in plants and animals, and a brief summary of some of the results of the twin method of research in cattle. The frequency of twinning, factors causing twinning, the genetics of twins, embryology of twins, and the effects of various prenatal circumstances on twinning, are discussed in successive chapters.

A later chapter is devoted to a discussion of the remarkable intra-pair correspondence among twins in the amount of glutathione in the blood. Although this varies within individuals over a period of time, yet these variations usually occur simultaneously within the members of a pair of twins. This phenomenon, known as isoglutathionemia, was discovered by Gedda over 10 years ago. His subsequent investigations of 154 pairs of twins indicate that all monozygotic twins and approximately 85% of dizygotic twins are isoglutathionemic. Yet it apparently does not occur among groups of single-born individuals, even siblings, or between parents and children. These observations emphasize the fact that although dizygotic twins and siblings possess the same degrees of similarity in hereditary makeup, the two types of twins possess other types of similarities not existing between single-born individuals.

Five chapters contain extensive reviews of investigations of the occurrence of anatomical, physiological, pathological, and psychological variations and mental abnormalities in human twins. The final chapter presents an excellent discussion of methodology in studies of human twins. Methods of twin diagnosis, evaluations of the relative effectiveness of heredity and environment, calculation of the manifestation of penetrance, the co-twin control method of Gesell, and the twin family method of Kallman are each considered in some detail. Although one chapter is devoted to plant and animal twins, they are scarcely mentioned thereafter. Notable advances have been made in the design and interpretation of experiments with cattle twins in recent years, and some discussion of them would have been appropriate in the chapter on methodology.

Taken as a whole, the book is unusually well-balanced and well-organized. Printed in large type on an excellent grade of paper and rich in illustrations, it is exceptionally attractive. It fills a long-felt need and should do much to stimulate interest in twins and twin research.

DAVID C. RIFE

AN ATLAS OF THE CHROMOSOME NUMBERS IN ANIMALS. *Second Edition (First American Edition).*

By Sajiro Makino. Iowa State College Press, Ames. $5.00. XXX + 290 pp. 1951.

This is a compilation of all the animal chromosome numbers that had been determined up to 1950, not including those of the Protozoa. The painstaking labor involved is truly awe-inspiring, and to Makino must go the thanks of biologists from all over the world for a difficult task so successfully accomplished. No list either as complete or as reliable has been published since those of E. B. Harvey which appeared in 1916 and 1920. Some comprehension of the magnitude of the present task becomes possible when it is stated that whereas Harvey listed about 1100 species, Makino gives 3317. The book is well bound and should offer stout resistance to the hard wear that it will undoubtedly receive.

The information is given in parallel columns, and covers the diploid and meiotic chromosome numbers, special remarks, and references. Unavoidably such a compilation has some omissions and errors. Those involving chromosome numbers are very few, but mistakes in spelling are more frequent. There are one or two serious taxonomic mistakes—such as listing the species of the homopteran family Aleyrodidae in

the family Coccidae—but such missteps are too few to affect the essential value of the work.

The most serious criticism pertains to the readability of the tables. No doubt for reasons of economy, this American edition represents an offset printing of a typewritten copy. Not only are all the imperfections of the original copy thus reproduced, but the fact that the ordinary typewriter is limited to one size of type renders it difficult to make typographic distinctions between the names of classes, subclasses, orders, suborders, and families. More skilful spacing might have alleviated some of the difficulty, but it may as well be recognized that for such an undertaking a typewritten version can never be fully satisfactory. It is to be hoped that it will be possible to issue future editions in regular printed form and that this will be spacious enough to avoid the crowding seen in the present book. If an index of the genera were to be added, the value of the book to the biologist would be still further enhanced.

Withal, and in its present form, the book will prove to be endlessly useful. Makino merits being ranked with the compilers of logarithmic and similar mathematical tables as a benefactor to toiling scientists.

FRANZ SCHRADER

CYTOLOGY AND CELL PHYSIOLOGY. *2nd Edition.* *Edited by Geoffrey H. Bourne. Oxford University Press, New York and London.* $10.00. xvi + 524 pp. + 2 pl.; text ill. 1951.

Bourne's book needs no introduction to most biologists, but in the 10 years which have passed since the appearance of the first edition many new data and interpretations have come to light and bear on present-day cellular concepts. The vast amount of information arising out of the studies of nucleic acid is one example of this. While there are works dealing with selected aspects of the general field of cytology and celluiar function, no single work has attempted, until now, to provide a synthesis that would supply an over-all picture of the working cell. No single volume could, of course, encompass all fields, for this is biology in its entirety, but the newer findings, through 1948, have been incorporated so as to bind more closely the fields of biology and chemistry. In addition, the book has been further enriched, and made more widely useful, by 2 new chapters, one by Honor B. Fell on Histogenesis in Tissue Culture, the other by E. N. Willmer on Some Aspects of Evolutionary Cytology. It should be pointed out that the latter chapter is concerned with the evolution of cell types, and not with chromosomal evolution. As a reference book, Bourne's volume stands in a class by itself, and its usefulness becomes more obvious with each reading.

C. P. SWANSON

THE CHROMOSOMES. *4th Ed.* *By M. J. D. White. John Wiley & Sons, New York; Methuen & Co., London.* $1.50. x + 124 pp. + 1 pl.; text ill. 1950.

A reprinting of the Second Edition of 1942 (*Q.R.B.*, 19: 62. 1944).

INVESTIGATIONS INTO THE DEVELOPMENT OF THE PITUITARY AT HEREDITARY ANTERIOR PITUITARY DWARFISM IN MICE *With Reference to the Pathogenesis of the Anterior Pituitary Dwarfism. Opera ex Domo Biologiae Hereditariae Humanae Universitatis Hafniensis, Vol. 7.* *By Torben Francis. Ejnar Munksgaard, Copenhagen.* Kr. 18.00 (paper). 169 pp. + 12 pl.; text ill. 1944.

This careful histological study of the pituitary gland in Snell's dwarf-throwing strain of mice reveals a hypoplasia of the anterior pituitary lobe far earlier than in the inferior endocrines in dwarf individuals. Between the 14th and 15th fetal days, the primitive anterior lobe anlage becomes differentiated into a glandular organ. The glandular parenchyma change in dwarfs occurs between the 20th fetal day and the 12th day after birth. There is an increase in relative numbers of small pyknotic acidophiles and small pyknotic chromophobes, with a reduction in the relative numbers of typical acidophiles which are apparently the hormone-producing cells. The estimates of cell numbers were made by examining serial sections rather than by making actual cell counts, the former method giving a truer picture of the relative numbers of the different cell types than the latter method.

Twelve days after birth it is possible to identify dwarfs on the basis of weight, body length, and tail length. With advancing age, dwarf mice lose all typical acidophiles and display few typical chromatophobes. The relative numbers of small pyknotic acidophiles and small pyknotic chromatophobes are greatly increased.

The author offers the following hypothesis of cell change in the anterior pituitary of a normal mouse: typical chromatophobes develop into hypoacidophiles which in turn become typical acidophiles, the hormone-producing cells proper. The latter may either liberate their secretion, becoming hyperacidophiles, or may store their secretion, to become large acidophiles. Hyperacidophiles may return to the state of typical acidophiles or may degenerate into small pyknotic acidophiles, which further deteriorate into small pyknotic chromatophobes. In very young dwarfs some hormones are produced for a short time by typical acidophiles. In dwarfs 6 to 7 weeks old the cell cycle must involve a successive change of chromatophobes to hyperacidophiles, then to small pyknotic acidophiles, and finally to small pyknotic chromatophobes. The first known point of attack of the gene in mouse dwarfism is thus in the anterior pituitary lobe. The hypoplasia of

sex glands and renal cortex is entirely or in part owing to the deficient anterior pituitary.

The author compares hereditary anterior pituitary dwarfism in man, which results usually from a tumor on the anterior pituitary, with the case in mice. The monographic form in which the study is presented, including all data and complete references to past literature, makes the work more valuable than if it were published in a condensed form. The 12 pages of excellent microphotographs confirm the author's conclusions. The English translation from the Danish is good. The reviewer could offer no suggestion beyond a minor change in prepositions in the title.

SARAH B. PIPKIN

GENERAL AND SYSTEMATIC BOTANY

THE FRESH-WATER ALGAE OF THE UNITED STATES. *New Second Edition.*

By Gilbert M. Smith. McGraw-Hill Book Co., New York, Toronto, and London. $10.00. viii + 719 pp.; ill. 1950.

The appearance of a revised edition of Smith's *Fresh-water Algae* is welcome news to the many algologists and hydrobiologists who have relied upon the excellent earlier edition variously as textbook, reference work, or field guide. Although the total number of pages has remained the same, about 100 new genera are described and a like number of new figures, admirably drawn and reproduced, has been added. The detailed treatment of species found in the earlier edition has been omitted. New groups treated are the cryptophyceae, the Chloromondales, and the Charophyceae.

It is interesting to note that in the new edition *Vaucheria*, studied in elementary botany courses as a green alga showing tubular organization, has taken up its taxonomic abode among the yellow-green algae. The new evidence validating this change comes from the similarity in the complement of plastid pigments found in *Vaucheria* and other Xanthophyceae. In the future it may be expected that biochemical and physiological criteria will find increasing application as supplementary guideposts in the taxonomy of the algae.

FRANCIS HAXO

THE CULTURING OF ALGAE. *A Symposium. Papers Presented at the Annual Meeting of the Phycological Society of America, New York, December 26–31, 1949.*

Edited by Jules Brunel, G. W. Prescott, and L. H. Tiffany. Charles F. Kettering Foundation, Dayton, Ohio. $2.25. x + 114 pp. + 2 pl.; text ill. 1950.

A most successful feature of the 1949 Christmas meetings of the Phycological Society of America was a symposium on algal culture. The 6 papers presented, along with an introduction by S. H. Hutner, have been published as this small attractive book. One may wonder why a 114-page book should merit three editors, especially since none of these either contributed to the text or is concerned in the main with culture work himself. In so far as culture methods are concerned, the book is almost exclusively freshwater in scope. There are two sentences of general directions for obtaining marine organisms in culture on slides and one formula for a marine culture medium, Erdschreiber's. Other areas of algal culture, similarly, are omitted or receive merely incidental mention, e.g., the culture methods used in studies of marine unicellular forms, genetics, soil algae and diatoms. Solid media techniques and the techniques for utilizing algae in bioassays or other quantitative work are likewise not to be found.

The chapters are as interesting and different in approach and organization as are the authors. H. C. Bold almost humorously points out some of the pitfalls in which the phycologist finds himself when attempting to study algae from the classical herbarium specimen. He makes it clear that studies in vivo and in vitro, preferably with pure cultures, are greatly to be desired. Bold also points up the major problem, that of the establishment of a pure culture collection. The progress already made in establishing and maintaining such cultures is reviewed in brief by E. G. Pringsheim in The Soil-water Culture Technique for Growing Algae. This chapter is essentially a description of the results obtained with this one technique, along with a description of Pringsheim's other more successful methods.

Results being obtained today from the use of pure cultures form the subject matter of a contribution by Gerald C. Gerloff et al. Pure-culture initiation from stocks of blue-green algae radiated with ultraviolet light are discussed. Interesting details regarding the responses to the presence and concentrations of various inorganic ions are given along with growth responses of one blue-green alga, *Coccochloris*, to variations in pH. Though nitrogen fixation was not considered, Gerloff's approach for such studies of algal physiology seems to be the method that can be expected to yield most understanding in this very critical area. Additional techniques which would expedite such studies are reviewed by Jack Myers in the topic The Culture of Algae for Physiological Research.

The chapters by Pringsheim, Gerloff, and Myers, and a fourth by Paul M. Cook, entitled Large-scale Culture of Chlorella, lead the reader respectively through the aspects of algal culture in test-tubes, flasks, special flasks, or large bottles to the pilot plant studies preliminary to algal farming. The earlier of these 4 chapters are to be noted for their descriptions of methods of isolation and the maintenance of stock pure cultures. The later chapters, in contrast, emphasize other aspects of culturing, such as the physiology of growth, problems of efficient population densities,

and harvesting. These 4 chapters as a series provide a rather provocative forecast of the use of unicellular algal forms in industry as sources of materials of direct use to man, and as new research tools.

The book closes on an entirely different note, a well-done chapter with the title Culturing of Marine Algae in Relation to Problems of Morphology, by G. F. Papenfuss. This chapter is a very good review of the historical development of systematic phycology, its present status, and the many problems that can perhaps be successfully attacked by the use of cultures. Unfortunately, little seems yet to have been devised in the way of culture methods for the larger marine forms discussed. No pure culture work is reported. The expansion of current opinions up on algal systematics, with diagrams of phyletic schemes, could hardly have been expected in a book of this title to have received such thorough coverage. Their inclusion is certain to be accepted with delight by the systematically inclined phycologist.

An appendix has been added to include formulae for 9 of the more important culture media. Unfortunately, cross references between the appendix and the text are inconspicuous or absent; and one of the formulae, to which a page is devoted, is a repetition from p. 33 in the text. Had this page been devoted to an index, the reader would not be so handicapped in attempting to use this work for reference. Despite the frustrations instilled by the restricted scope of the volume and its lack of an index, this book is well worthwhile.

MAXWELL S. DOTY

CATALOGUS LICHENUM UNIVERSALIS.

By Alexander Zahlbruckner. Gebrüder Borntraeger Leipzig; The Johnson Reprint Corporation, New York. $185.00 (reprint edition; 10 volumes including index). 7360 pp. [1922–1940]; 1951.

All 10 volumes were originally issued in 4 parts, the first of which appeared in May, 1921, the last in February, 1940. The first 8 volumes and index (Vol. 9) were edited by Alexander Zahlbruckner, Director of the Botanischen Abteilung des Natürhistorischen Museum in Wien. The tenth volume was edited after Zahlbruckner's death by his colleague Karl Redinger, who died after achieving the task.

The work was conceived by Zahlbruckner who, as a cryptogamic taxonomist, recognized the need for a complete, systematic bibliography to lichen species and their literature. In the Introduction to the first volume, he stated the general plan of the work: To prepare a critical listing of all known lichen species, systematically arranged and numbered by families, genera, species, varieties, and forms according to the order which he followed in his "Flechten" (*Lichenes*) in Engler-Prantl's *Natürlichen Pflanzenfamilien* (1. Teil, Abt. 1). Each species is cited by the recognized binomial, followed by synonyms and homonyms in chronological order. In each case he gives all known literature citations, with particular reference to illustrations and exsiccatae. Notes on substratum and geographical distribution are also given. Zahlbruckner's *Lichenes* appeared in two editions, in 1903 and 1926, with considerable changes, which he applied to the latter part of the *Catalogus*. International Nomenclatural Rules are adhered to in all cases; consequently there are numerous revisions in the text, as synonyms and homonyms were exposed during the editing of the manuscript. In the Vorwort to Vol. 10, Redinger states that the series would be continued at 10-year periods.

Unfortunately, the traditions which gave the Natural History Museum at Vienna preeminence in lichenology has ceased with the death of these two great scientists, and if the work is to be brought up to date, as it certainly should be, it must be done by others. If possible the style, quality, and format achieved by Zahlbruckner should be continued.

When the first parts of the *Catalogus* appeared, many felt that the cost was excessive and put off ordering it. Others looked hopefully for used sets in antiquarian catalogues. The work has very rarely been listed for resale. World War II saw the destruction of many private and public copies in Europe, while the stored unsold sets and the plates were also destroyed. In the United States there are probably about 10 complete original sets available. Its great value lies in the fact that the *Catalogus* is a compendium of lichenological data, from before Linnaeus to 1940, offering both bibliographical and taxonomic information of fundamental use to the professional student of lichens and to allied workers in botany. It is essential in curating large collections. For the student it brings the world of lichen literature to his immediate service with a minimum of effort, introducing him directly to the old and recent workers who have published in rare, obscure, or modern journals. The lack of availability of this work for American workers has been reflected, unfortunately, in the less scholarly approach and obvious errors of past studies. It should be available in the botanical libraries of all colleges and universities.

One cannot presume to criticize a study which has withstood the test of time and the demands of many capable lichenologists. Its merits are well established, and the occasional errors in volume, page, or year citations can be easily noted. These volumes will stand as a monument to the prodigious energy and knowledge of Zahlbruckner, placing him at the front of his generation's lichenologists, and to the loyalty and ability of his friend Karl Redinger. Now that this large and scholarly work is reasonably available, we may look forward to more students and better studies of lichens throughout the world.

GEORGE A. LLANO

LICHENS OF THE STATE OF WASHINGTON.

By Grace E. Howard. University of Washington Press, Seattle. $3.00 (paper). x + 191 pp. + 11 pl. 1950.

The author reports upon some 8 years of field collecting and the examination of material in 5 herbaria. The total number of species and varieties considered is 335, comprising 69 genera and 28 families. A general discussion of lichen morphology and brief analyses of the topography and climatology of Washington are presented in the Introduction. A Glossary supplies definitions of special terms. Artificial keys to genera are grouped under three life forms: crustose, squamulose-foliose, and fruticose. Adequate synonymy, brief descriptions, notes on the substratum, and localities are cited for each species. Keys to species are also available. This systematic record will be welcomed by all interested in the cryptogamic botany of Washington; it covers an area historically rich in early records.

The reviewer wishes that the author had considered in greater detail certain aspects of the research. The phytogeography, especially of the larger lichens, should show a relation between the Channeled Scabland and dusty Palouse plateaus in contrast to the three high mountain areas—the Rockies, the Cascades, and the Olympics. The mountains themselves differ enormously in structure, topography, and climate, and corresponding differences in flora have been noted. This would have offered a sound basis for ecological interpretations. The author reports the distribution solely by counties, and even this artificial service is incomplete. No records are available for 10 per cent of the 39 counties; 33 per cent are cited with less than 10 localities. 10 per cent are based on 10 to 20 collections, 25 per cent are for for 20 to 50, and 20 per cent for 50 to 150 records. "Washington Territory" and "West Coast of North America" represent 2 per cent of all records. Such general references by early collectors are not easy to fix, but they might have been localized to smaller areas, particularly in the case of types and unusual records. The addition of a list of local collectors would have been appreciated in this, the final report. Collectors since 1860, particularly Americans are well represented. The bibliography could have been enriched with more, if possible with all the botanical references to works on the lichens of Washington. The topographic map by Shedd is hopelessly inadequate for purposes of analysis nor does it reflect any credit to the brilliant geomorphology of this State. A map showing counties is essential; our European colleagues would concur in this. Systematically, the treatment follows Fink's *Lichen Flora of the United States*. The extension of many of the species is too often based on too little material, while the total absence of new species or varieties may lead some to conclude that there is little more to be expected from our Northwest.

GEORGE A. LLANO

THE SMUT FUNGI. *A Guide to the Literature, with Bibliography.*

By George William Fischer. Ronald Press Co., New York. $6.00. x + 387 pp. 1951.

In the last 4 or more decades a very large number of books, bulletins, and other papers have been published bearing upon the biology and control of smut fungi (Ustilaginales), in addition to the publications primarily upon the taxonomy of these fungi. For those persons undertaking research into the life-histories and control of smuts it has been necessary until now to search the literature from many lands, and in many languages, a matter almost impossible in the majority of research institutions because of the difficulty, not to mention expense, of assembling the publications. G. W. Fischer's book does not save the student from the necessity of reading the essential articles, but shows him what has been published, where, when, and by whom. It will prevent the waste of energy and time in doing what might prove to be duplication of effort and of publication. Also it will provide the foundation of literature upon which the superstructure of further research may be built.

The references to the biology and control of smuts appear under the headings: Control; Culture on Artificial Media; Cytology; Heterothallism and Sex; Hybridism and Genetics; Life History, Parasitism and Factors Affecting; Longevity of Spores; Miscellaneous Records; Physiologic Specialization; Spore Germination and Factors Affecting; and Varietal Resistance and Susceptibility.

Part I consists of the subject-matter guide to the literature under the foregoing headings, 25 genera and 330 species being considered. For a few of these the record consists of a single reference, but for widely investigated species, such as *Ustilago maydis* and *Tilletia caries*, 10 to 15 or even more pages of the text are occupied. References for Ustilaginales General occupy over 6 pages. The nomenclature followed in Part I is that of the late G. L. Zundel's still unpublished manuscript *The Ustilaginales of the World*. Under each species are listed chronologically the known synonyms. Then follow the subject-matter headings. Under each are given, also in chronological order, the names of the authors cited, with dates and citation numbers for the Bibliography, which makes Part II of this work. This Bibliography, alphabetically arranged, contains 3353 items. It is noteworthy that the literature, even of recent years, from the lands behind The Iron Curtain seems to be well covered. The references include not only the publications on the biology and control of smut fungi, but also the more important ones on the taxonomy and geographical distribution of these organisms. It is perhaps to be regretted that these last-mentioned works were not listed separately or given a special heading in Part I. The reviewer has noted a few minor typographical errors, especially in the citation of papers in foreign languages, but these are so

few that they do not mar the excellence of the book. It is to be hoped that this fine work will stimulate specialists to undertake similar publications on other groups of fungi of special interest to plant pathology, e.g., the Uredinales, Erysiphales, or Peronosporales.

ERNST A. BESSEY

GLOSSARY OF THE BRITISH FLORA.

By H. Gilbert-Carter; preface by Charles E. Raven. Cambridge University Press, New York and London. $1.75. xviii + 79 pp. 1950.

The scientific names of plants are primarily tools for ready reference to the objects designated by them. Beyond that, they often have unusual meanings, or relate a peculiar bit of history. Information of this kind is not always found in manuals designed for the identification of plants, but it invariably contributes a great deal to the enjoyment of knowing and understanding plant names. This glossary contains nearly all names currently used in British floras, along with those to be included in the exhaustive new British Flora now in preparation. Each entry is accompanied by a definition, Latin or Greek root, and other pertinent comments. Most names require one or two, sometimes more, lines, as in the case of *Oenothera*. Rarely was the author obliged to write "derivation unknown" (see *Legousia*). The Introduction (pp. xi–xvi) contains observations and recommendations on accentuation, derivation of names, and a list of Greek letters with their Latin equivalents. A short bibliography (p. xvii) lists important botanical and classical sources of words and names. The "approximate pronounciation of the Latin letters" is shown on p. xviii. Equipped with this glossary, students and professional botanists alike will greatly increase their enjoyment and understanding of the scientific plant names pertaining to the British flora.

THEODOR JUST

FAMILIES OF DICOTYLEDONS. *A New Series of Plant Science Books, Vol. XXV.*

By Alfred Gundersen; with introductory chapters by Chester A. Arnold, Oswald Tippo, Theodor Just, Herbert F. Copeland, J. Herbert Taylor, and W. H. Camp; drawings by Maud H. Purdy. Chronica Botanica Co., Waltham, Mass.; Stechert-Hafner, New York. $4.50. xvi + 237 pp.; ill. 1950.

The grouping of organisms in such a manner that natural affinities are given proper cognizance is at best a difficult and time-consuming task, and one for the specialist with many years of experience behind him. Among the dicotyledonous group of plants, it is recognized that while the Englerian system, with the Magnoliales forming the most primitive order, represents the most satisfactory basis of organization, many categories at various hierarchical levels are arbitrary and are maintained for convenience only. Floral morphology can no longer be regarded as the only criterion of affinity, and the impact of anatomical, cytological, embryological, and geographical studies has been felt in taxonomic circles. Having this in mind, the author has regrouped the families to conform with the latest evidence. The result is a combination of the Englerian system with that of Bentham and Hooker, and the departures are mostly regroupings within orders rather than between orders. The point is made, however, that the arrangement is to be regarded as tentative only, and subject to improvement.

In addition, a number of introductory chapters on paleontology, wood anatomy, carpels and ovules, embryology, cytotaxonomy, and geography, each by a different authority, serves to indicate the manner by which these studies can be brought to bear on problems of taxonomic interest. The important point is stressed that no single botanical discipline can be relied upon to solve questions of familial relationships.

C. P. SWANSON

THE CACTI OF ARIZONA. *Second Edition.*

By Lyman Benson; line drawings by Lucretia Breazeale Hamilton. University of Arizona Press, Tucson. $4.00. xiv + 134 pp. 29 pl.; text ill. 1950.

The first edition of this book filled a long-felt need by providing a usable, accurate, and attractive volume on the cacti of the Southwest. With a bit of study, even the amateur could successfully classify those forms which he encountered. The professional botanist found it authoritative enough for his purposes, with good keys, ample photographs, and distributional maps. The 2nd edition differs in that certain revisions, notably in the genus *Echinocereus*, have become necessary as the result of field and herbarium studies carried on since 1940. Much of this work has been made possible through the development of suitable techniques for preserving herbarium specimens, and thus permitting detailed comparisons of closely related forms at one's leisure in the herbarium, followed by more accurate and extensive studies in the field. Benson deserves much credit in bringing this unusual group of typically American plants to the attention of a wide audience.

C. P. SWANSON

FLOWERS OF THE MEADOW.

By Geoffrey Grigson. Penguin Books, Harmondsworth, Middlesex; Allen Lane, Baltimore. 75 cents. 36 pp. + 24 pl. 1950.

Those who enjoy flowers in their natural state will derive much pleasure from reading this small volume

on the meadow flowers of England. The treatment is appreciative rather than strictly scientific, and the short text is followed by 24 colored plates of the more common species, done in water-colors by Robin Tanner.

C. P. SWANSON

FLOWERING TREES AND SHRUBS IN INDIA.

By D. V. Cowen. Thacker & Co., Bombay. Rupees 22/8. xviii + 137 pp. + 45 pl.; text ill. 1950.

In the words of the author, this book is written for "ordinary people with little or no knowledge of botany but with a love of beauty and an interest in this country." The identification key provided as a guide is therefore based on flower color. In thus writing for the interested layman, the author has done a remarkable piece of work not only as a botanist but as an artist as well. Each species described is accompanied by a colored plate, many of them exquisite, while additional pencil sketches are interspersed with the text. The descriptions are non-technical, and provide information which the layman rather than the professional botanist would seek—items relating to economic value, derivations of names, native lore, etc. It is an altogether attractive and delightful book.

C. P. SWANSON

A FIRST BOOK OF TREE IDENTIFICATION.

By Matilda Rogers; photographs by Wynn Hammer. Random House, New York. $2.50. 95 pp. 1951.

Through the use of excellent photographs and a simple text, the author has provided a ready means by which the more common trees can be identified. It is a book which anyone can use when the trees are in foliage since leaves provide the best means of identification, although some attention is given to the bark and to habits of growth. The many half-tone photographs are excellent. The book should prove useful of individual study or for group discussions in field botany courses.

C. P. SWANSON

A NATURAL HISTORY OF TREES *of Eastern and Central North America.*

By Donald Culross Peattie. Houghton Mifflin Co., Boston. $5.00. xviii + 606 pp.; ill. 1950.

The history of our country has, in a way, been molded by our great forest reserves: the enormous stands of white pine through which "a squirrel could travel a squirrel's lifetime without ever coming down," and which furnished the spars for our sailing vessels, the pumpkin pine for colonial furniture, lumber for every conceivable purpose, and the wealth of many of America's first families; the white oaks for the keels of ships, for flooring, and for tight cooperage; the walnuts for gunstocks and beautiful furniture; the maples for sugar and for bird's eye and curly veneers; and the dogwoods, shadblow, laurels, rhododendrons, and redbud for incomparable beauty. A host of other trees of lesser dimensions, value, and beauty grow among them to add, each in its own way, to the variety of our landscape and to the economy of our daily existence. It is with these things, together with brief passages on identifying features and distribution, that Peattie has concerned himself, and he tells a magnificent story of a magnificent heritage. Much of the story is that of the past, since our lumbering practices, fires, and agriculture have left few stands of virgin timber remaining to give a glimpse of what was once a seemingly inexhaustible supply of the finest trees. It is a story worth reading, and the book is heartily recommended to anyone who looks upon trees as part and parcel of our American scene, and worthy of more than a nodding acquaintance. It is to be hoped that Mr. Peattie can do similarly with the trees of the South and the West.

C. P. SWANSON

WEIZEN, ROGGEN, GERSTE—*Systematik, Geschichte und Verwendung.*

By Elisabeth Schiemann. Gustav Fischer, Jena. DM 13. (paper). 102 pp.; ill. 1948.

As the taxonomy of our cereals is far from being completely understood, the publication of this monograph dealing with wheat, rye, and barley may be regarded as an important event in the advance of our knowledge of these plants. Prepared as part of the treatment of the grasses (Gramineae-Triticeae) by R. Pilger scheduled for publication in the second edition of Engler and Prantl's *Die natürlichen Pflanzenfamilien*, it was published independently, since the rest of that volume was destroyed during the air attack on the Botanical Museum of Berlin-Dahlem on March 1, 1943. These circumstances account for the delimitation of the subject and the style adopted in the preparation of the manuscript, as well as for the published version.

A thorough taxonomic revision of these genera has long been needed. Miss Schiemann undertook this difficult task in the light of the extensive published literature and on the basis of her own research. Her treatment of barley (pp. 71–94) is limited to the cultivated species, comprising the section Cerealia, whereas that of rye (pp. 60–70) is based on the entire genus, including the wild species of section Agrestes, and that of *Triticum* (wheat, pp. 7–59) excludes the genera *Agropyrum* and *Aegilops*.

The 14 species of *Triticum* recognized by Miss Schiemann belong to 3 cytologically and morphologically well marked series: 1) Monococca or Diploidea, 2n = 14, with 2 species; 2) Dicoccoidea or Tetraploidea, 2n = 28, with 8 species; and 3) Speltoidea or Hexaploidea,

2n = 48, with 4 species. These series, their representative species and cytological as well as other characteristics are listed in tables 1 and 2. According to Vavilov, the three series have different geographical centers of origin or gene centers, Asia Minor, Abyssinia, and Central Asia, respectively. However, Miss Schiemann, as she has discussed in detail in one of her earlier papers, does not share Vavilov's view that gene centers are synonymous with centers of origin. The various modes of speciation in *Triticum* are summarized under two headings: infra-specific and supra-specific factors. The treatment of individual species includes their synonymy, morphology, physiology, variability, distribution, taxonomy, history, phylogeny, and special literature. Unfortunately, distribution maps are omitted. A schematic representation of the phylogeny of wheats, based on Flaksberger's treatment of the genus (1936) as reworked by Miss Schiemann, is found on page 95. The mass of diversified information concerning all aspects of the cultivated as well as wild species treated in this monograph is astonishing. In addition to the important taxonomic and genetical data given, the reader will find numerous interesting details relating to the prehistory and history of many species and their migrations, together with facts regarding uses, cultivation, yields, parasitic fungi, and hybrids. The treatment of the other genera follows the sequence and style adopted for wheat. The illustrations are clear and well selected, some having been adopted from published sources, but the majority representing original figures. Three useful indices conclude this compact monograph, which should be in the hands of all those who are interested in or work with these genera of cereals.

THEODOR JUST

PLANT PHYSIOLOGY

ANNUAL REVIEW OF PLANT PHYSIOLOGY. *Vol. 2. Edited by Daniel I. Arnon and Leonard Machlis. Annual Reviews, Stanford, California.* $6.00. x + 361 pp. 1951.

This new annual has already established itself as a hardy perennial. The misgivings with which many plant physiologists greeted its appearance, misgivings based on a desire not to isolate botanical thought from the mainstream of biochemistry and physiology, have now largely vanished. Indeed, the general excellence and timeliness of the reviews are the best possible answer to the early skeptics; they reflect, in general, the good judgment of the editors as well as the wisdom and literacy of the reviewers.

Volume II opens with a review of the Mechanism of Absorption and Transport of Inorganic Nutrients in Plants (R. N. Robertson). The subsequent articles are: The Role of the Mineral Elements in Plant Nutrition (E. J. Hewitt); A Critical Survey of the Physical Background of Photosynthesis (J. Franck); The Kinetics and Chemistry of Photosynthesis (H. Gaffron and E. W. Folger); Biosynthesis of Chlorophyll and Related Pigments (S. Granick); Respiration—The Pasteur Effect in Plants (J. S. Turner); Formation, Occurrence and Inactivation of Growth Substances (P. Larsen); Herbicides and Selective Phytotoxicity (G. E. Blackman, W. G. Templeman, and D. J. Holliday); Nutritional Requirements of Isolated Plant Tissues and Organs (P. R. White); Frost, Drought and Heat Resistance (J. Levitt); Experimental Morphogenesis in Vascular Plants (R. H. Wetmore and C. W. Wardlaw); Gas Damage to Plants (M. D. Thomas); and Permeability (H. B. Steinbach).

Of the 17 authors represented, 9 are Americans, 5 are British, 2 are Australians and 1 is a Dane currently living in the United States. This certainly represents a better balance than the first volume, in which 24 of the 27 authors were American, and 10 of these were Californians! It is certainly to be hoped that this trend toward greater cosmopolitanism continues. One may perhaps also voice the desire that in the years to come not all the articles will be written by men who have previously contributed reviews on similar subjects to this or other journals. The *Annual Reviews* tend to set the mood for research to come, and it is thus important that new and perhaps younger voices occasionally be permitted to recite the progress in their chosen field.

ARTHUR W. GALSTON

ECONOMIC BOTANY

MUSHROOM GROWING. *A Practical Manual. By R. L. O. Jackson; illustrated by Philip Osborn. English Universities Press, London.* 9s. 6d. viii + 103 pp. + 4 pl.; text ill. 1950.

Comparable in scope to Rettew and Thompson's *Manual of Mushroom Culture*, this little volume deals with the cultivation of commercial mushrooms under British conditions, and is clearly based upon the first-hand experience of the author. The style is straightforward and direct, enabling a somewhat technical subject to be dealt with in a simple way. Topics considered include the design and construction of buildings suitable for mushroom growing, the preparation of compost, filling, spawning, and casing of the beds, care of the crop, picking, and marketing. Fungus diseases and insect pests affecting the crop are described, and specific control measures are advocated. The reviewer was particularly impressed with the final chapter, which is concerned with problems with which mushroom growers must contend in the future, including the development of a satisfactory synthetic compost, mechanization, the improvement of mushroom varieties by breeding or selection for better quality and increased

disease resistance, and cooperative efforts to develop canneries in order to utilize surplus crops.

F. T. WOLF

BASIC HORTICULTURE. *Revised Edition.*

By Victor R. Gardner. Macmillan Co., New York: $4.75. xii + 465 pp. ill. 1951.

This revised edition of *Basic Horticulture* presents certain factual information and illustrative material which will acquaint the student with the various fruits, vegetables, and ornamental plants and their culture methods; and also will give him an understanding of their structure, how they grow, and how they react to their environment. This basic information is designed to train the student to think for himself and thus acquire the ability to solve those problems which may arise in later years. A series of questions and answers is a means to this end.

The chapter headings indicate the scope of the work: The Place of Horticulture in American Agriculture; Classifications of Plants; Plant Structure and Plant Growth; Specialized Buds and Stems; Temperature Relations of Plants; Water as a Limiting Factor; Light as a Limiting Factor; Plant Nutrients as Limiting Factors; Water and Nutrient Intake, Translocation, and Utilization; Carbohydrates; Growth and Fruitfulness; Flower-bud Differentiation and Flowering Habits; Training Horticultural Plants; Pruning; Flowers, Fruits, and Seeds; Propagation; Hormones and Growth Regulators; The Culture of Annuals; The Culture of Biennials, Herbaceous Perennials and Bulbous Plants; The Culture of Woody Perennials; Plant Pests and the Injuries Caused by Them; Control of Plant Ills; Weeds and Their Control. Suggestions for laboratory work, a glossary, and an index complete the work.

ALBERT F. HILL

FUNDAMENTALS OF HORTICULTURE. *A Textbook Designed for Course in General Horticulture.*

By. J. B. Edmond, A. M. Musser, and F. S. Andrews. Blakiston Co., Philadelphia, New York, and Toronto. $5.50. xiv + 502 pp.; ill. 1951.

The purpose of this book is to enable the student to acquire a working knowledge of the fundamentals of plant growth, to develop the ability to apply this knowledge, and to obtain an appreciation of the value of horticulture in human affairs. It should be valuable not only to students of general horticulture, but to those primarily interested in fruits, vegetables, or ornamental plants as well. The text is based on the assumption that only one factor should be discussed at a time; later, when the student has a grasp of the basic principles, the interrelations of several factors are taken up.

Part I, entitled Plant Growth and Development, treats of the fundamental processes. Part II, Principal Horticultural Practices, discusses the application of these processes to various horticultural practices. Part III deals with the principal horticultural crops, fruits, vegetables, and ornamental plants. Under fruits, the pome, drupe, and citrus fruits, grapes, brambleberries, strawberries, currants, gooseberries, blueberries, cranberries, pecans, walnuts, filberts, figs, persimmons, dates, avocados, and the tung tree are discussed. The vegetable crops include those grown for their stems and leaves, for their fleshy vegetative structures, or for their fruit or seed. The treatment of ornamental plants comprises chapters on Commercial Floriculture, Nursery Plants, and on Horticulture and the Home. A list of selected references and an index conclude the work.

ALBERT F. HILL

A CHECK LIST OF BOOKS AND PAMPHLETS ON GRAPES AND WINE AND RELATED SUBJECTS, 1938–1948.

By Maynard A. Amerine and Louise B. Wheeler. University of California Press, Berkeley and Los Angeles. $5.00. viii + 240 pp. 1951.

The enormity of the literature on grapes and wines will be certain to amaze anyone who has not worked in that field. This bibliographical list includes 1789 titles published during the 11-year period it covers. There are also indexes of subjects, of authors, editors, and translators, and of countries or states of publication. The volume is lithoprinted. It represents one more contribution to the essential task of rendering accessible the wartime scientific literature. In fields such as viticulture and enology (wine-making), in which there is little exchange of literature or periodicals even in peacetime, bibliographic works such as this make a most important contribution.

HOW TO GROW VEGETABLES. *The Complete Garden Guide to Planning, Growing, Preserving, and Storing Vegetables, Fruits, and Berries.*

By Lloyd C. Cosper and Harry B. Logan; photographs and drawings by Lynette Arouni. Duell, Sloan and Pearce, New York. $3.50. x + 263 pp.; ill. 1951.

For the individual who knows nothing about gardening, and who is hesitant to do anything about it without competent advice, this book is recommended. No steps are left unexplained, from the purchase of suitable tools through the planting of seed to the harvesting of the crop. Fruits and berries are considered as well as vegetables, and the only item omitted about which the amateur will need advice is a list of selected varieties. The authors in justice, cannot be censured for this omission, since such a listing is an almost impossible

task, and one which, if included, would have taken all the joy and romance out of the seed catalogs.

C. P. SWANSON

THE PROPAGATION OF ALPINES.

By Lawrence D. Hills. Pellegrini & Cudahy, New York. $5.00. 464 pp. + 27 pl.; text ill. 1951.

The rock-gardener, by nature and by necessity, is a more patient individual than he who sticks to the conventional perennial border, for his charges are more restricted as to habitat, shorter as to blooming season, more delicate and varied as to texture and form, and more difficult generally as to successful cultivation and propagation. As the title indicates, this volume is concerned principally with the methods of increasing alpines, first in much detail as to general methods, and then individually as to species. In both respects, the book is uniformly sound and informative. One can incidentally, however, gain a fund of information of other sorts which appears here and there throughout the chapters, and especially in the excellent appendix dealing with botanical terminology. Written for British gardeners and with the British climate in mind, the book is not so narrowly applicable, and gardeners throughout the temperate regions can profit from its pages.

C. P. SWANSON

GROWING WOODLAND PLANTS.

By Clarence and Eleanor G. Birdseye; drawings by Walter L. Graham. Oxford University Press, New York. $4.00. xii + 223 pp. + 1 pl.; ill. 1951.

Clarence Birdseye has led a rather remarkable life, and one attended with success in several seemingly unrelated fields. As the pioneer in frozen-food products, he is well-known; as a horticulturist, even in an amateur sense, he was, until the publication of this volume, relatively unknown. The quality of the book, however, is such as to bring success again to a most versatile individual, assisted in this venture by an equally versatile and enthusiastic wife. This is a book for the gardener who can resist the seed catalogs, and who finds pleasure in the less flamboyant species of the woodlands. The necessary procedures fot the successful cultivation of woodland plants are given with grear detail. and the reader should have little difficulty in following the directions outlined. The technical aspects are followed by a description of some 200 of the better-known species of southern Canada and the northern United States, but the principles involved are applicable to any climate. Having personally viewed the results of the authors' excursion into the growing of woodland plants at the Birdseye estate in Gloucester, Mass., the reviewer is convinced that the text is based on first-hand experience, and is not the result of compilation solely for the sake of publication.

C. P. SWANSON

FLORICULTURE. *Fundamentals and Practices. Second Edition.*

By Alex Laurie and Victor H. Ries. McGraw-Hill Book Co., New York, Toronto, London. $5.00. x + 525 pp.; ill. 1950.

Gardening is not a static art, for the tastes of individuals change, new varieties are being constantly produced, and new practices, insecticides, and fungicides are tested and found to be satisfactory. The authors have been aware of these trends in floriculture, and have included a discussion of them in their second edition, making this volume one of the best of the available textbooks in this field.

TULIPOMANIA.

By Wilfrid Blunt. Penguin Books, Baltimore. 75 cents. 32 pp. + 16 pl. 1950.

Introduction of the tulip from Asia Minor into Europe in the late 1500's was followed by an interest in the flower that can only be regarded as an example of mass hysteria. The tulipomania reached its climax in 1634–37, when in Holland a single bulb of the variety "Semper Augustus" was sold for approximately 5000 florins, and a bulb of the black tulip was held to be almost priceless. This fantastic financial bubble inevitably burst, and laws were enacted to prevent such wholesale speculation in Holland, although a similar but less spectacular mania occurred somewhat later in Turkey. From these circumstances, however, came the tulip of today, far lovelier than its early ancestors, but like it "the peacock among flowers; the one has no scent, the other no song." This volume deals principally with the events leading up to the collapse of the speculations, and to the text are added 14 reproductions in color of varieties known in 1659.

C. P. SWANSON

THE AURICULA. *The Story of a Florist's Flower.*

By Rowland H. Biffen. Cambridge University Press, New York and London. $3.00. 164 pp. + 8 pl. 1951.

Primula auricula is typically an English flower, but one which nevertheless has added much to American gardens. As an alpine flower, the auricula combines compactness of form with a wide variety of petal color, foliage shape, and amount of meal, the latter a silvery powder which forms on both leaf and petal, making it a plant which fits the needs of the small as well as the estate

gardener. Sir Rowland writes on his subject with enthusiasm and authority, covering the history of the species for garden and show purposes, its cultivation, and its breeding potentialities. The volume is recommended for those gardeners who have the curiosity and the patience to carry out a small breeding program of their own.

C. P. SWANSON

VERTICAL FARM DIVERSIFICATION.

By D. Howard Doane. University of Oklahoma Press, Norman. $2.75. xvi + 184 pp. + 8 pl. 1950.

This little volume should prove most provocative and stimulating to anyone interested in the advancement of agriculture, as it presents a practical workable solution of one of the greatest problems of farm management. The author is an expert in the field and is particularly well qualified through long experience to write such a book.

The phrase "vertical farm diversification" may be defined as the act of carrying a farm operation one or more steps beyond the actual production of raw materials. It involves the performing of tasks ordinarily carried on by middlemen or retailers, with resulting additional profit to the farmer, and demonstrates the advantages to be derived from growing more and more of the most profitable crops. The diversification may consist of transportation, grading, packaging, processing, storing, or even direct selling by either the individual farmer or by cooperative organizations.

The general practice of vertical farm diversification not only will improve the financial position of the farmer himself, and shorten and make more efficient the distribution of farm products, but it will tend to create and stabilize a desirable urban-rural balance in our society as well.

ALBERT F. HILL

WEEDS, *Guardians of the Soil.*

By Joseph A. Cocannouer. The Devin-Adair Co., New York. $2.75. viii + 179 pp.; ill. 1950.

This book has been distributed by the publishers' Farmer's Book Club and is along the same vein as other organic farming books. The informal style should make pleasant reading for the audience intended, namely, farmers and suburban gardeners. Since it is not a scientific treatise supported by experimental data, it will not find its way to many biologists' bookshelves. It abounds with the author's experiences with soil improvement through the agency of weeds, and there is much reiteration of the main theme as the author attempts to drive his point home. The entire text could have been condensed into a single chapter.

Some of the principal points put forth by Cocannouer are that deep-rooted weeds, upon penetrating the subsoil, open up the surface soil to better drainage and aeration; nutrient elements that may be depleted in the surface soil are replenished from the subsoil reservoir when weed growth is incorporated into the surface soil; water rises to the surface soil from the subsoil by capillarity along the external surfaces of the weed roots and thus is available to cultivated crops during periods of drought; run-down farm land can be returned to a high state of productivity if weeds are permitted to take over for several seasons.

The author does not suggest that weeds should be permitted to take over our gardens and farms completely, but advocates the controlled use of weeds for maintaining high soil fertility.

C. E. MINARIK

DECIDUOUS ORCHARDS. *Second Edition, thoroughly revised.*

By William Henry Chandler. Lea & Febiger, Philadelphia. $6.50. 436 pp.; ill. 1951.

The second edition of this standard textbook in pomology follows the pattern set by the first edition in emphasizing the nature, processes, and relationships of deciduous orchard species, rather than orchard practices. In Part I, detailed and coordinated information is presented regarding the various processes involved in the setting and development of fruits, and in mature fruits. Part II treats of the environmental influences that affect these processes. In Part III, the 3 chapters are devoted to propagation, transplating, and pruning. Part IV comprises a discussion of orchard species which points out their relationships to each other, the important varieties, special aspects of their fruits and fruiting processes, and special responses to various factors of the environment. The fruits include the apple, pear, quince, plum, apricot, peach, cherry, mulberry, fig, persimmon, papaw, pomegranate, and jujube. The nuts discussed are the almond, pistachio, walnut, hickory, pecan, hazelnut, filbert, and chestnut. A chapter is also devoted to the tung tree. The book concludes with a Bibliography of 272 recent articles reporting research concerning fruit trees, and an Index.

ALBERT F. HILL

TEXTBOOK OF DENDROLOGY *Covering the Important Forest Trees of the United States and Canada. Third Edition. The American Forestry Series.*

By William M. Harlow and Ellwood S. Harrar. McGraw-Hill Book Company, New York, Toronto, and London. $5.00. xiv + 555 pp.; ill.; frontispiece in color. 1950.

This revision of a popular forestry textbook will be welcomed by both students and teachers of dendrology as well as those possessing a less professional interest in the important forest trees of the United States and Canada. The original organization of the material, with its high degree of descriptive clarity and taxonomic accuracy, has been preserved in the new edition. As the authors point out in the new Preface, the changes or additions which have been made have been due to our increasing knowledge of the trees rather than to any detectable changes in the trees themselves during the 8 years intervening since publication of the second edition.

Although scattered small changes or additions in the descriptions of species have been made, the conspicuous changes and additions are concerned with such silviculturally superficial revisions as those concerned with nomenclature and ranges. Scientific names have been brought into agreement with the *International Rules of Botanical Nomenclature* and common names coincide with the *U. S. Forest Service Check List.* In those cases where *Check List* common names do not agree with *Standardized Plant Names* (sponsored by the American Joint Committee on Horticultural Nomenclature) or with common trade names, the alternative common names are noted. The introduction has been revised and expanded and a glossary, giving the derivation of most scientific names, has been added.

For those unfamiliar with this book, note should be made that it is neither encyclopedic nor local in its treatment but is primarily designed to acquaint the student forester with the important forest tree genera of the United States and Canada. For this reason about three-quarters of our approximately 1000 native tree species are not described. Instead of employing detailed taxonomic keys, the distinguishing characteristics of families, genera, and species are presented in tabular form.

SCOTT S. PAULEY

DECIDUOUS FORESTS OF EASTERN NORTH AMERICA. *By E. Lucy Braun. Blakiston Co., Philadelphia and Toronto.* $10.00. xiv + 596 pp. + 1 folding map; text ill. 1950.

The purpose of this book is to present a comprehensive view of the entire deciduous forest complex of eastern North America. In the words of the author, she has attempted "*first*, to portray what is (or was) present in any geographic area and to reconstruct the pattern of original forest insofar as the fragments remaining permit; *second*, to give data on composition and aspect of forest communities in all parts of the deciduous forest; and *third*, to trace through geologic time the development of the present pattern of forest distribution."

The wide field experience of the author in the deciduous forest regions, coupled with an apparent intimacy with the literature, has resulted in a highly satisfactory fulfilment of these aims. The material is well organized and illustrated. The numerous halftone prints, depicting representative plant communities of the various forest regions, are of excellent quality. Ninety-one tables illustrating forest composition, and 8 reference maps are included in the text. An additional large-scale map, showing forest regions and sections, is attached on the inside of the back cover. Also included are a bibliography of well over 500 references and 2 indexes, one of scientific and common plant names, and one of general subject matter.

Although an early chapter of the book is devoted to a definition of the ecological terminology employed, the inclusion of a glossary of terms would have been helpful for those unfamiliar with the specialized language characteristic of this field. This book is of interest and value to ecologists and foresters as well as less specialized professional botanists and botanical hobbyists.

SCOTT S. PAULEY

PRINCIPLES OF SILVICULTURE. *By Frederick S. Baker. McGraw-Hill Book Co., New York, Toronto, and London.* $5.00. xii + 414 pp.; ill. 1950.

This textbook, designed for use by the undergarduate forester, represents an effort to assemble and discuss the wide variety of facts and principles which constitute the biological basis for the practice of silviculture. Thus, as the author points out, this is a book on *silvics*, which he defines as "a knowledge of the nature of forests and forest trees, how they grow, reproduce, and respond to changes in their environment."

Although this book represents a worthwhile summary of our present silvical knowledge, it serves also the equally valuable function of emphasizing how little we really do know about our native tree species. The only marked deficiency of the book stems from the author's preoccupation with the environmentalist approach. This has resulted in a failure to acquaint the student with the basic biological concept that "responses to the environment" in forest trees are fundamentally manifestations of interactions between genotypes and environments. The important theoretical and practical implications of individual variation and fluctuation below the species level are essentially ignored, and the student is thus left with the impression that responses in individual trees of a species may be safely predicted in terms of the environment alone. Such criticism could have been avoided had the author included an up-to-date revision of the chapter entitled Forest Genetics which appeared in his *Theory and Practice of Silviculture* (McGraw-Hill, 1934).

SCOTT S. PAULEY

FOREST MENSURATION. *Third Edition.*

By Donald Bruce and Francis X. Schumacher. McGraw-Hill Book Co., *New York, Toronto, and London.* $5.00. xviii + 483 pp. 1950.

This is an elementary textbook designed to acquaint forestry students with the essential background necessary to solve the common problems of forest mensuration. The original approach of the authors to the subject, with emphasis placed upon an explanation of statistical tools rather than upon the procedures by which they may be applied, has been preserved in this edition. For this reason material concerned with older mensurational tools is essentially unchanged, but a new chapter, discussing the use of aerial photographs, has been added. Several chapters which illustrate the practical application of mensurational tools have been completely rewritten.

SCOTT S. PAULEY

STATE CONTROL OF PRIVATE FORESTRY UNDER EUROPEAN DEMOCRACIES. *A Survey of Developments in Eight Countries of Western Europe in the Decade 1938–1948. Oxford Forestry Memoirs, No. 22.*

By M. L. Anderson. Oxford University Press, London and New York (printed in Great Britain). $3.50 (paper). 112 pp. 1950.

This report of a survey of the relationship of the state to private forestry in several countries of western Europe (Belgium, Denmark, Finland, France, The Netherlands, Norway, Sweden, and Switzerland) is based on personal study tours and a review of the literature made by the author in 1947 and 1948. Although primarily concerned with developments during the decade 1938–48, this memoir summarizes earlier legislation bearing on the subject for each of the countries discussed. The result is a concise and authoritative résumé which should be of particular interest and concern to American foresters.

SCOTT S. PAULEY

THE PLANT DOCTOR. *The How, Why and When of Disease and Insect Control in Your Garden. Third Edition, with a Calendar for the Northeast and Special Chapters for Other Sections.*

By Cynthia Westcott. J. B. Lippincott Co., Philadelphia and New York. $3.00. 231 pp.; ill. 1950.

This revised edition of the author's popular handbook on garden practices should be very useful and valuable to all who are interested in the growing of plants. The earlier editions were widely used by gardeners, members of garden clubs and similar organizations, and by many others. It may be assumed that the present edition will be as useful. The greater portion of the book is given over to the control of insect pests and plant diseases but recommendations in regard to other garden practices, such as soil preparation, fertilization, and grafting, are included. The subject matter is largely concerned with ornamental plants. Having had many years of practical experience in garden and disease control work and in caring for private gardens, the author is thoroughly acquainted with most gardening operations, and in this handbook has been able to evaluate the various measures which have been and are now recommended for the control of pests and diseases.

The book is written primarily for use in regions with climatic conditions similar to those in the vicinity of New York City, but its usefulness will not be confined to such regions. It is written in a calendar form. For each month there is listed what should be done during that month and what preparations should be made for future months. Considerable attention is paid to the chemicals now being used to control pests and diseases. Detailed recommendations are made as to how and when these are to be used and what dusting and spraying equipment is necessary.

In chapters on special troubles in other parts of the country, the Middle West, Southeast, Southwest, California, and Northwest, some of the interesting and important pests and diseases of ornamental plants are listed and described, along with recommendations for their control. The information is based largely on observations made by the author during her numerous trips to these regions, but she has also included the results of her own investigations during two winters on the control of azalea petal blight in the Gulf Coast area. The book closes with a very useful dictionary or glossary which contains the common names of most of the ornamental plants, insect pests, plant diseases, insecticides, fungicides, and other common terms used by gardeners.

C. W. EDGERTON

PLANT BREEDERS OF THE FUTURE. *Introductory Counsel for Students. "Up-To-Date in Biology," No. 2.*

By Gordon Haskell. The Biological Press, London. 3s. (paper). 34 pp. 1950.

The introductory lectures given to botany students about to embark on a course in plant breeding have been condensed into this abbreviated pamphlet which sketches the possibilities and pitfalls that lie in the future of plant breeding, together with a discussion of the training which a plant breeder requires to carry out his tasks effectively. Most of the illustrative examples are drawn from researches completed, or in progress, at the John Innes Horticultural Institution.

GENERAL AND SYSTEMATIC ZOOLOGY

GRUNDRISS DER ALLGEMEINEN ZOOLOGIE.

By Alfred Kühn. Georg Thieme, Stuttgart. DM 15.60. viii + 281 pp.; ill. 1949.

Almost 30 years have passed since the first edition of Kühn's *Grundriss der allgemeinen Zoologie*. During most of that period, it has been the leading textbook in its field for the German university student. Generations of competent biologists have found it an invaluable foundation. It is sufficient to say of it that it is not exclusively devoted to a morphological survey of animal types, but is centered around the exposition of major biological principles; that it has been kept up to date; and that its diagrams as well as discussions would afford numerous suggestions for improvement to the writers of American zoology textbooks.

Twenty years ago, when he was a graduate student, the reviewer spent a summer reading an early edition of Kühn's textbook in order to extend his reading knowledge of the German language and in particular to expand his working vocabulary of German scientific terms. No better advice could be given the American graduate student who is faced with a similar task today than to do likewise. Not only should the primary aim be accomplished, but as a bonus he will obtain also a very worthwhile review of general zoology, with insights not likely to be gained from any books in our own language.

Today Alfred Kühn, past what would be in this country the age of well-merited retirement, remains a great leader in German zoology. At Tübingen, both in the University there and at the Max-Planck Institut für Biologie which he heads, he labors to repair the damaged fabric of German biology. His vast knowledge and infectious enthusiasm inspire all younger workers. His warm, genial spirit is undoubtedly helping to kindle true democracy in Germany today.

BENTLEY GLASS

THE LIVING TIDE.

By N. J. Berrill. Dodd, Mead & Co., New York. $4.00. xii + 256 pp. + 16 pl. 1951.

According to the anonymous bard of the dust jacket, Professor Berrill "creeps among their tidewater ledges to watch the gulls at their daily housekeeping and child-raising. He dives below the surface to study the sedentary security of the barnacles." Fortunately, the text is deficient in such passages of studied elegance; purple is not the favorite color in N. J. Berrill's literary palette, and his book is not a series of exposés of the intimate lives of creatures with quaint sexual aberrations. It is rather a gathering of sketches, short pieces about various animals, and experiences at Tortugas, in the Maritime Provinces and in New England. Professional zoologists, who will find most of this book a twice-told tale, will regret that the author did not say a little more about the laboratory at Tortugas and the people who worked there, and will wonder how he managed to get the Hopkins Marine Station and the Pacific Biological Laboratories mixed up and why he passed up the opportunity to set down his impressions of Ricketts. Now and then, in his efforts to popularize, the author has oversimplified and cut his story a bit too short, but the book as a whole presents a satisfactory picture of the work of a marine zoologist on his field trips.

JOEL W. HEDGPETH

LIFE OF THE SHORE AND SHALLOW SEA. *Second Edition, revised and reset in new format.*

By Douglas P. Wilson. Nicholson & Watson, London. 15s. xviii + 213 pp. + 44 pl. 1951.

This second edition of one of the finest of all the seashore books has been freshened by a change of photographs and brought up to date by a complete overhaul of the text made possible by resetting the book in a new and handier format. To those who may not be able to decide between this book and Yonge's *Sea Shore*, we can only recommend that they buy both.

JOEL W. HEDGPETH

THE LITTORAL FAUNA OF GREAT BRITAIN. *A Handbook for Collectors. Second Edition.*

By N. B. Eales. Cambridge University Press, London and New York. $3.75. xviii + 305 pp. + 24 pl.; text ill. 1950.

The 2nd edition of this standard manual contains the same illustrations, and virtually the same text as the edition of 1939. New references have been added, together with descriptions of eggs and egg capsules, and the appendix has been augmented with brief outlines of field methods in seashore ecology. This has been accomplished with the addition of but 4 pages over the first edition.

JOEL W. HEDGPETH

BLØDDYR. *III: Ferskvandsbløddyr. Danmarks Fauna, Bd. 54. Ferskvandssneglenes Aegkapsler by Poul Bondesen. Tilføjelser og Rettelser til C. M. Steenberg: Bløddyr I, by G. Mandahl-Barth.*

By G. Mandahl-Barth. Dansk Naturhistorisk Forening; G. E. C. Gads Forlag, Copenhagen.

Kr. 14.00 (paper). 249 pp.; ill. 1949.

This treatise, one of a series dealing with the fauna of Denmark, is devoted to the mollusca of land and freshwater. It is far more than a record of species taken. The anatomy of the different families is described in detail, and the radulae and nidamental capsules of the gastropods are accorded special attention. The importance of the latter has never been appreciated. Some years ago the late Frank Collins Baker attempted the generic separation of the American species of *Physa* from those of the Old World, but the proposal did not meet with a very enthusiastic response, because the

anatomic features upon which the distinction was predicated proved to be not of primary importance. Had he based his proposal upon the eggs he might possibly have carried his point, for the eggs differ more widely than do the animals. Thus the eggs of *Physa heterostropha* (as well as other American species) have 2 vitelline membranes, quite unlike those depicted in the excellently drawn figures given by Bondesen for the Danish species.

The extent to which both land and freshwater shells vary is astonishing. Three species of *Helix*, two of which occur also in America, are represented in Denmark by 7, 27, and 35 named varieties, respectively, in addition to the types, and many more unnamed varieties. Two species of *Lymnaea* of circumpolar distribution vary greatly in both hemispheres, but the two series of variations seem to be parallel. Yet each series has been given its own set of names. It would seem that the number of varietal names might be reduced to the great relief of all who have to struggle with the nomenclature of this genus.

A surprising fact brought out in this work, and of which the reviewer was unaware, is that *Physa heterostropha* and *Lymnaea columella* from the eastern United States, *Helisoma tenue* from the Pacific North American slope, and *Lymnaea peregrina* from Brazil have all been introduced into Denmark and are apparently flourishing there.

The figure of *Bithynia tentaculata* is not exactly like the American species known by this name. Perhaps the latter is worthy of subspecific rank. Also the figure of *Bithynia leachii* looks like an *Amnicola*, but again the form of the egg case is decisive and vindicates the author's generic assignment. However, the generic names *Bithynia*, *Margaritana*, *Monacha*, and *Eulota* are not legal under the rules of the International Commission.

A surprising feature of this work is the use of accents to indicate pronunciation, which incidentally in Denmark differs from the practice in this country. Some names which we accent on the penult, take the accent on the antepenult in Denmark. On the other hand, where we accent "Gastropoda," all family names, and some trivial names on the antepenult, the Danes prefer the penult. Differences of this sort help to defeat the supposed advantage of Latin as a medium of scientific expression.

There is an index of 69 entries including synonyms—a great help. It is surprising to see how much more the English language has in common with Danish than with German. Perhaps this is to be expected; after all, though the Saxons came from Germany the Jutes came from Denmark and the Angles from Schleswig. Any English-speaking person with even a rudimentary knowledge of Danish should have no difficulty in reading this book.

JOSHUA L. BAILY, JR.

SIPHONAPTERA FROM CENTRAL AMERICA AND MEXICO. *A Morphological Study of the Aedeagus with Descriptions of New Genera and Species. Fieldiana: Zoology Memoirs, Vol. I.*

By Robert Traub. Chicago Natural History Museum, Chicago. $4.00 (paper). 127 pp. + 54 pl. 1950.

This memoir is based upon the personal collection of the author while a member of the Fourth Hoogstral Biological Expedition to Mexico as well as on the collections of various museums from which he obtained material. The memoir is difficult to summarize because of its technical details and the highly specialized study of the aedeagus. The work will prove invaluable to students of the Siphonaptera (fleas).

Part I is devoted to a study and description of new and old species from the region indicated. In all, some 25 new species and 6 new subspecies are described. In the family Ceratophyllidae the genera *Jellisonia*, *Pleochaetis*, and *Kohlsia* (new) are revised with keys to species; in the family Hystrichopsyllidae notes, comments, and new species are described in the genera *Ctenophthalmus*, *Strepsylla* (new) and *Corrodopsylla;* in the family Pulicidae a single new species is described.

Part II is devoted to a comparative study of the morphology of the aedeagus of Siphonaptera from Mexico and Central America. In this study the author follows closely the detailed work of Snodgrass (1946). The avowed purpose is "to emphasize the practibility of using the aedeagus for taxonomic purposes," and in consequence Traub stresses those structures that are visible in cleared and mounted fleas. In all, he describes with beautiful illustrations the aedeagus of 26 genera from the 5 families represented; representatives of the sixth family occur only in South America and Australia. The author does not attempt to give us a key to these families based on the structure of the aedeagus, an important omission. It is in fact doubtful whether such a key can be devised, as genitalic structures may prove of more value for species and generic purposes.

The work concludes with a bibliography and 54 full-page plates of beautiful line drawings.

ROBERT MATHESON

THE MORPHOLOGY AND PHYLOGENY OF AUCHENORHYNCHOUS HOMOPTERA (INSECTA). *Illinois biol. Monogr., Vol. XX, No. 4.*

By Sol Kramer. The University of Illinois Press, Urbana. $2.00 (paper); $3.00 (cloth). viii + 111 pp.; ill. 1950.

In the introduction the author states: "The problems of phylogeny within the orders of insects, concerning families and lower groupings, remain virtually unsolved." To attack this problem the author gives us a detailed study of representatives of 5 families of the Auchenorhyncha (Homoptera), a single species from each family. These are *Scolops pungens* Germar (Ful-

goridae); *Tibicina septemdecim* Linn. (Cicadidae); *Lepyronia quadrangularis* Say (Cercopidae); *Aulacizes irrorata* Fabr. (Cicadellidae); and *Cerasa bubalus* Fabr. (Membracidae). These are common species, selected not because the author considered them primitive but because of their abundance. After a detailed study, with numerous excellent illustrations, of the external anatomy (including the appendages) of the head, thorax and abdomen and the muscles of the same regions, Kramer concludes with a discussion of the probable relationships of these 5 families. He outlines the phylogenetic interpretations of Osborn (1895), Kirkaldy (1910), Handlirsch (1908), Tillyard (1919), Singh-Pruthi ((1925), and Spooner (1938). As a result of his own investigations he makes certain general statements but does not attempt any new conclusions as to the phylogenetic relationships of these families.

A full bibliography completes the work.

ROBERT MATHESON

BRITISH MUSEUM (NATURAL HISTORY), RUWENZORI EXPEDITION *1934—35. Volume II. No. 6. Muscidae. C.-Scatophaginae, Anthomyiinae, Lispinae, Fanniinae* and *Phaoniinae.*

By F. I. Van Emden. British Museum, London. £ 2 5s (paper). Pp. 325–710; pl. 7–10; text ill. 1951.

The title of this publication might suggest that it is merely another list of old species of flies, with descriptions of some new ones collected by one more African expedition. This is far from the case, since the author has included the results of his concurrent studies of the very large faunal collections of the British Museum (Nat. Hist.) and the Commonwealth Institute of Entomology with the many specimens and species taken by the British Museum's Expedition to the East African Ruwenzori Mountains. As a consequence, Van Emden has made available to systematists the most complete taxonomic treatise ever published on the many Ethiopian genera and species belonging to these subfamilies. Despite the many species available, several previously described ones were not represented, but have been included on the basis of their descriptions. Too frequently such a course has resulted in the confusion of similar species, but this time has been avoided by the author's significant annotations and by including them in several alternatives in the keys. When types of species were not available in the British Museum, conscientious efforts were made to obtain them, or else paratypes, and as a result much new and valuable synonomy has been made available. Due to conditions arising during the last War, the publication of this report was delayed for several years, a fact which necessitated the publication elsewhere of the specific keys to many of the genera, in order to make them more promptly available to entomologists working in Africa. By including a complete generic and specific index at the end of this volume, the inconvenience of tracing various species occasioned by this scattered publication has been eliminated. Even though over 10,000 specimens, representing 550 species, were studied, the author points out the still incomplete state of knowledge concerning their geographical distribution, although some generalities regarding the distribution of the more common Ethiopian and cosmopolitan species are presented. He has also estimated that one-quarter to one-half of the species likely to be found in the Ethiopian region still remain undescribed. His thought-provoking remarks concerning the occurrence of subspecies having dichoptic males in holoptic species at high altitudes may be of interest to students of insect evolution. Phylogeny is not stressed. However, Van Emden's views that certain subfamilies, generally considered to be the most specialized, are actually the most primitive will probably surprise some dipterists. Ecologists will find a fund of generalized information about the habits of many of the species in the section Biology, which has been included on the basis of specimen labels and from publications of the late Alex Cuthbertson. Excellent use has been made in the keys of several morphological characters either overlooked or not emphasized by previous workers, while accurate figures supplement the detailed descriptions and aid considerably in presenting an over-all picture of many of the new species.

FRED M. SNYDER

A FIELD GUIDE TO THE BUTTERFLIES *of North America, East of the Great Plains.*

By Alexander B. Klots; paintings by Marjorie Statham; photographs by Florence Longworth. Houghton Mifflin Co., Boston. $3.75. xvi + 349 pp. + 40 pl.; text ill. 1951.

Here is a book of importance to all naturalists, particularly those who deal with insects. Based on the plan of the well known Peterson Bird Guides, it is especially designed to carry and use in the field. It is illustrated by Marjorie Statham with 247 paintings made from selected specimens, in addition to 232 photographs. Lines on the plates point to characters most useful in identification, a device used in previously published Guides of this series. The page of legends opposite each plate is unusually complete. For each species, in addition to general remarks, there are summaries of descriptions of the larva, food plants, life history notes, range, and subspecies. There are chapters on collection and preservation, the butterfly and its environment, life histories and growth, the adult butterfly, and classification. The Appendix contains sections on some principles of classification, literature, a checklist of species and races for the region treated, and also a very satisfactory index, divided into (1)

technical terms and general topics; (2) larval food plants; and (3) butterflies.

In a work designed primarily for accurate identification of butterflies, there is a surprising amount of important and up-to-date biological information. Major types of habitats and the butterflies which are found in them, representative photographs of such habitats, predators and parasites, protective form and coloration, habits and behavior, are some of the topics briefly discussed. Genetics, evolution, physiology, history, and other aspects are omitted or little mentioned, but this is practically necessary since the scope and size of the book are limited.

Keys to the families, and occasionally to smaller groups, are given. Abundant illustration and mention of separating characters reduce the necessity of having complete keys, which most beginners do not use anyway. Traditionalists will get some jolts when viewing name changes which have taken place in recent years. *Speyeria* and *Boloria* are now used instead of *Argynnis* and *Brenthis*, respectively. The Pearly Eye and the Eyed Browns are placed under *Lethe*, as befits world usage. All of the eastern Ringlets are considered as races of the European *Coenonympha tullia*, in accordance with studies by Davenport. The former races of the Wood Nymph *Satyrus alope* are all put under *Cercyonis pegala*. Whether the latter generic name will continue to hold is still uncertain. For once, the name of the Monarch has suffered no change but remains *Danaus plexippus* (for the moment anyway). The familiar *Phyciodes nycteis* Crescent spot is now the Silvery Checkerspot, *Melitaea nycteis*.

In preparing this work Klots has had the advantage of extensive field work over much of the country, wide biological interests, and close acquaintance with some of the best collections and well-known specialists. The result is a book which is indispensable to all who have any interest in the subject. Let us hope that this guide will shortly be followed by one on the butterfly fauna of the West.

RALPH W. MACY

BRITISH WATER BEETLES. *Volume II.*

By Frank Balfour-Browne. The Ray Society, London; sold by Bernard Quaritch, London. 27s. 6d. xx + 394 pp. + 1 pl.; text ill. 1950.

This volume contains the tribes Colymbetini and Dytiscini of the family Dytiscidae and the family Gyrinidae. The first volume, which appeared in 1940, covers the rest of the Dytiscidae and the Haliplidae and Hygrobiidae. The book is a very careful monograph, well printed and well illustrated with drawings of morphological details. These drawings make the features necessary for a differentiation of the species and genera much clearer than many words could do. Keys are given of the genera and species. Data on the biology and habits are very extensive. Maps of the distribution within the British Isles are given, and the total distribution beyond this is indicated in the text. It is clear throughout the text that much of the material comes from the author's own observations. An extensive bibliography concludes the book.

The taxonomic treatment is straightforward. The author rejects, in contrast to many other European workers, all names of color aberrations and varieties. When questions of synonymy are troublesome, they are fully discussed. The author does not find it necessary to recognize any subspecies.

This book, though restricted to the British Fauna, should be useful also to American workers because of the thorough treatment of the morphology and the many biological and ecological facts given. Practically all of the genera treated in this book occur also in North America and a number of species are common to both continents. Those who are actively engaged in straightening out the American species should find a great deal of value in this book.

G. H. DIEKE

LARVAE OF THE ELATERID BEETLES OF THE TRIBE LEPTUROIDINI (COLEOPTERA: ELATERIDAE). *Smithsonian Misc. Coll., Vol. III, No. 11. Pub. 3987. Thomas Lincoln Casey Fund.*

By Robert Glen. The Smithsonian Institution, Washington, D. C. $1.65 (paper). vi + 246 pp.; ill. 1950.

For most groups of beetles the morphology of the immature forms is much less well known than that of the adults. The reasons for this are obvious. For positive identification of the larva it is necessary to rear it to adulthood, which in most cases is a tedious and painstaking process that does not yield quick and numerous results. Nevertheless, a knowledge of the larvae has proved of great importance for the natural classification of many groups.

The monograph of Glen on the larvae of the Lepturoidini (which include the Hypnoidini and Melanactini) is the result of more than 20 years' work. The author studied all the larvae of this tribe which were accessible to him—a total of 83 species. Sixty-six of these are from North America, the rest from the Old World. The tribe contains some of the most important wireworm pests. The monograph is chiefly a detailed morphological and taxonomic study, but many observations on the biology of the group are also recorded. Keys based on larval characters of the subfamilies of the Elateridae, of the tribes of the Pyrophorinae, the genera and species groups of the Lepturoidini, and finally to the individual species are given. The monograph will be chiefly of use to the specialist, to whom indeed it will be indispensable, since it represents a vast amount of original work as well as an account of pre-

vious work on this group and a detailed bibliography. On the basis of his studies the author suggests many changes in the taxonomic status of species and genera. Naturally it must be realized that because of the restricted material some conclusions have to be tentative. The paper is illustrated by extensive drawings of morphological details.

G. H. DIKE

THE LIFE OF VERTEBRATES.

By J. Z. Young. Oxford University Press, New York and London. $8.50. xvi + 767 pp.; ill. 1950.

This book, in the words of the author, is "an attempt to define what is meant by the life of vertebrates and by the evolution of that life." It "represents an attempt to give a combined account of the embryology, anatomy, physiology, biochemistry, paleontology and ecology of all vertebrates." Here, then, is a bold and timely departure from the well-established precedent of categorizing various aspects of vertebrate life and discussing them in terms of one or another of the disciplines enumerated. Many biologists will agree wholeheartedly with Young that these divisions are not acceptable, since all "are concerned with the central fact of biology, that life goes on. . . ." Only by combining the results achieved by these diverse disciplines is it possible to define the organization of the whole of vertebrate life, the way in which it has evolved, and the way in which its continuity is maintained. Happily, *The Life of Vertebrates* is not, as it very well might have been fashioned by an author less competent, simply an encyclopedic compendium. It is a completely integrated, thoughtful, scholarly work in which the central theme of the unity and continuity of vertebrate life is faithfully developed from beginning to end. Implementing the high standard of scholarship exemplified throughout the book is an easy, refreshingly readable style.

Because this book is essentially a textbook, the presentation of its subject matter is basically didactic. This is wholly appropriate and fittingly subserves the primary function of such a book. On the other hand, because its specific aim is to define a general scheme of the organization of the whole of vertebrate life, broad and sweeping generalizations are formulated and presented according to the author's point of view. There is no question of the desirability of this. At the same time, however, the pervasive didactic treatment tends to obscure the occasionally inherent instability of particular lines of reasoning. For example, there is by no means universal agreement concerning the answer to the difficult question of the origin of chordates. In this book certain ideas concerning this are presented very skilfully and forcefully. A sophisticated reader will recognize that these may or may not be correct, may perhaps be able to evaluate them according to his own concepts, and will grasp the significance of the author's careful placement of the reasoning on the level of probability. Others, however, might be led to infer that the ideas presented here are final and incontestable. The point to be stressed is that in its fundamental manner of presentation *The Life of Vertebrates* shares an inevitable limitation of textbooks generally. This generic attribute of didacticism must be recognized in order to evaluate fairly the truly unique and outstanding features of the book.

Successful achievement of the author's projected goal—the development of a unified picture of vertebrate life and evolution—is attributable in large measure to the coherency and continuity of the book's over-all organization. This is consistent and effective throughout. In general, the arrangement is systematic, proceeding from discussion of the earliest chordates to the mammals. A detailed discussion of mammalian organization, however, is left for a separate volume.

The first chapter begins by outlining the need for generality in zoology. Here is stressed the necessity for looking beyond the details of individual lives and for endeavoring to find rules governing all. In order to do this, the biologist must know as much as possible of the life of the whole organism with which he deals; and beyond this he must know something of the whole population from which a particular specimen is drawn. In general, therefore, one must meet the requirement of directing study continually toward populations rather than single individuals, in order to achieve an understanding of the organization of life. Accordingly, "we must try to think of all the creatures of a kind, spread out wherever a suitable habitat for them occurs." Since individuals and populations alike are subject to change, it is important to attempt to define quantitatively the nature of the relation of life to its environment. Young makes the attempt, and endeavors to show, first, how the organization of vertebrate life has become more complex since it first appeared, and second, that the increasing complexity is related to the adoption of modes of life successively more remote from those characterizing the earliest ancestral forms. Hence the first chapter concludes with a brief survey of the evidence for climatic and geographical changes which may be related to changes in organic life. The cyclical nature of these climatic and geographical changes is stressed.

Chapter Two outlines the general plan of chordate organization, exemplified by *Amphioxus*. There is then developed, in Chapter Three, the thesis of the origin of chordates from filter-feeding animals. In this connection the author discusses and rejects the theories of Patten and Gaskell. The reasoning he favors and develops very skilfully is based upon the views advanced originally by Bateson and by Garstang. These views of course are open to question. The evidence for the relationship between echinoderms and chordates is by no means conclusive. The extreme

view has even been expressed fairly recently that the different phyla of animals may have arisen independently. However, one cannot reasonably expect an exposition of all facets of so complicated a problem in a book of this nature.

The content of succeeding chapters can only be indicated here by enumerating the succeeding chapter headings: The Vertebrates without Jaws—Lampreys; The Appearance of Jaws—The Organization of the Head; Evolution and Adaptive Radiation of Elasmobranchs; The Mastery of the Water—Bony Fishes; The Evolution of Bony Fishes; The Adaptive Radiation of Bony Fishes; Lung-fishes; Fishes and Man; Terrestrial Vertebrates—Amphibia; Evolution and Adaptive Radiation of Amphibia; Life on Land—The Reptiles; Evolution of the Reptiles; Life in the Air—The Birds; Bird Behavior; The Origin and Evolution of Birds; The Origins of Mammals; Marsupials; Evolution of Placental Mammals. The 10 chapters following these are devoted to a discussion of the classification, characteristics, origins, affinities, and evolution of the orders of mammals. The concluding chapter (Chapter 32) summarizes the nature of the evolutionary changes of the life of vertebrates, and the factors influencing them.

It can be seen from these chapter headings that this is truly a panoramic survey of vertebrate life. That there is occasionally some repetition does not detract from the over-all continuity of the treatment. The illustrations are adequate both in quantity and quality. There is a fairly extensive bibliography and an index.

MAX KRAUSS

AMPHIBIANS OF WESTERN CHINA. *Fieldiana: Zoology Memoirs, Vol. II.*

By Ch'eng-chao Liu. Chicago Natural History Museum, Chicago. $7.50 (paper). 400 pp. + 10 pl.; text ill. 1950.

This is a most remarkable book. Although written in an even and prosaic style for specialists, many poignant and vivid pictures flash through the introductory portions of the volume. There is a brief account of the author's thrice-forced emigrations from eastern Chinese universities because of the Japanese invaders. The tremendous personal deprivations suffered by Liu and his colleagues and students during a long 2½-month journey are suggested. The journey westward across southern China started on a November midnight, with the Japanese Army just 10 miles away.

Liu also includes interesting anthropological observations about some of the peoples living in the remote areas along the Sino-Tibetan border where he did some of his collecting. On one of these trips the author contracted typhus and had to be carried, mostly unconscious, out of the Lolo country on a stretcher for 5 days before a hospital was reached.

The amphibians, like the people of the area, have many interesting and unusual features. There is, for example, a tree-frog, restricted to largely treeless country above 8000 feet altitude, that lays its eggs in little holes in the ground. Another tree-frog lays green eggs which are deposited on green leaves and stick to them. The tadpoles of certain species of *Staurois*, which live in rushing mountain cascades, have developed ventral adhesive suction disks for attachment to stones in the bed of the stream. A surface-feeding tadpole has its lips expanded into a funnel to collect its plankton food. Some of the salamanders deposit egg cases in which a series of eggs develops. One of the most important preditors on frogs' eggs is a species of giant planarian more than an inch in length. *Nanorana*, a small greenish frog, is confined to an altitudinal belt between 10,000 and 14,000 feet. There is an interesting parallelism with American folklore in that the Chinese also believe that they may acquire warts by touching their species of *Bufo*. Even the literature has an exciting temporal spread, one of the references being dated 600 B.C.

These unusual items are only a small part of this excellent volume. *Amphibians of Western China* contains 400 pages of solid descriptive zoology. Liu describes fully the 10 salamanders (including 5 new forms) and 66 frogs (including 13 new forms and 3 partly diagnosed but unnamed species) by giving a very complete account of each species. There is a number of keys to groups, both to adults and tadpoles, although there is no over-all system of identification keys for all the forms included.

The accounts of species are illustrated with India-ink drawings depicting diagnostic features. The illustrative material also includes 8 colored plates of western Chinese amphibians which are about the best of such published plates this reviewer can recall. They are the work of a young self-trained artist, I. S. Wang, and their publication was made possible by a contribution from Albert H. Wetten. Both of these men have contributed materially to the worth of this volume.

In a few minor ways this book could have been made even more useful. Allusion has already been made to the desirability of complete keys for the identification of the species discussed. The index is only to scientific names and could have been made more extensive. A brief systematic list of the forms considered would have been a desirable addition. Some readers will be concerned with the author's uniform failure to use parentheses in those instances in which their use is mandatory by the International Code of Zoological Nomenclature.

This volume is a substantial contribution to the biology of amphibians. Both C. C. Liu and the Chicago Natural History Museum deserve congratulations.

ARNOLD B. GROBMAN

CHECK-LIST OF BIRDS OF THE WORLD. *Vol. VII.* *By James Lee Peters. Museum of Comparative Zoology, Harvard College, Cambridge, Mass.* $6.00. x + 318 pp. 1951.

The present volume is the first in this series to reach the order Passeriformes. It includes the Eurylaimidae (broadbills), the Dendrocolaptidae (wood-hewers), the Furnariidae (ovenbirds), the Formicariidae (ant-thrushes), the Conopophagidae (ant-pipits), and the Rhinocryptidae (tapaculos). The broadbills are Oriental and Ethiopian, the rest are Neotropical, and not a single one extends north of the Mexican border. Previous volumes of this series listed synonyms subsequent to the appearance of Sharpe's *Hand-list*, but here, since Hellmayr's monographs on the Furnarioidea have withstood the test of time, the synonymy included in the latter is not repeated.

HENRI C. SEIBERT

THE BIRDS OF NORTH AND MIDDLE AMERICA. *A Descriptive Catalog of the Higher Groups, Genera, Species, and Subspecies of Birds Known to Occur in North America, from the Arctic Lands to the Isthmus of Panama, the West Indies and Other Islands of the Caribbean Sea, and the Galapagos Archipelago. Part XI: Family Cathartidae—The American Vultures; Family Accipitridae—The Hawks, Eagles, Kites, Harriers, and Old World Vultures; Family Pandionidae—The Ospreys; Family Falconidae—The Falcons and Caracaras. Bull. 50, Smithsonian Inst., U. S. natl. Mus.*

By Herbert Friedmann. Smithsonian Institution, Washington, D. C. $4.00 (paper). xiv + 793 pp.; ill. 1950.

Those familiar with this series of volumes on the Birds of North and Middle America will note that Ridgway's name has been dropped from co-authorship. The work, originally started by Ridgway, was after his death continued by Friedmann (Parts IX and X). In the present publication, the latter author has materially changed much of Ridgway's manuscript, revised many genera, studied much new material and therefore has generally not felt constrained to follow his predecessor's opinions. Part XI includes the diurnal birds of prey. As in previous volumes, generic details are illustrated, usually the head, foot, wing, and tail. Wherever a large genus, like *Buteo*, shows considerable variation, the subgeneric features are illustrated also. The anatomical details characterizing each genus are given, and for each species within the geographical scope of the volume there is a complete description of the plumages of both sexes, of juveniles, measurements, and range. A complete synonymy and bibliographic references through 1947 are an important feature of this work. Keys to the families, genera, species, and subspecies are provided.

HENRI C. SEIBERT

A CONTRIBUTION TO THE ORNITHOLOGY OF NORTHEASTERN VENEZUELA. *Proc. U. S. natl. Mus., Vol. 100, No. 3268.*

By Herbert Friedmann and Foster D. Smith, Jr. Smithsonian Institution, United States National Museum, Washington. Paper. Pp. 411–538; 3 pl.; text figs. 1950.

The junior author of this report spent about 3½ years in the states of Monagas and Anzoátegui, during which time he collected at least one specimen of nearly every species of bird that he observed in that region. This collection was identified by the senior author. Aside from the fact that this particular region of Venezuela was an ornithological blank, the collection is of value because data were recorded on the color of the soft parts, the condition of the gonads, and frequently information on the contents of the gizzards. Additional notes recorded in the field on behavior, nesting, and numbers of individuals add significant knowledge to this segment of neotropical birds, especially since some of these data suggest many interesting habits, such as seasonal movements on the part of some local species. The introduction provides a good survey of the physical aspects of the area, the ecological communities within it, and the birds characteristic of each community. What climatological data were available are also included. This report should therefore be examined by ornithologists other than those interested in taxonomy alone.

HENRI C. SEIBERT

LETTERS ON THE ORNITHOLOGY OF BUENOS AYRES. *By W. H. Hudson; edited by David R. Dewar; foreword by Herbert F. West. Cornell University Press, Ithaca, New York.* $2.75. xviii + 93 pp. 1951.

About the year 1865 W. H. Hudson, then an unknown young man residing in Conchitas, Argentina, began to send specimens to S. F. Baird of the Smithsonian Institution. Baird, whose sagacious counsel aided so many young naturalists, evidently felt that Argentina was somewhat beyond the scope of his institution. He sent Hudson's collections to P. L. Sclater in London for "inspection." A little later, in 1869 and 1870, there appeared in the *Proceedings of the Zoological Society of London* 12 letters written by Hudson and edited by Sclater, bearing the above title. Seven of the manuscript letters still exist. These are reprinted here in their original form, and it is interesting to learn that Hudson in his late twenties was still relatively unfamiliar with the English language.

Soon more ambitious plans were conceived, the letters were discontinued, and 20 years later there appeared the 2 volumes of *Argentine Ornithology*, by Sclater and Hudson.

After his early removal to England, Hudson became more the artist, less the scientist. In his later years

he was ever ready to volunteer a diatribe against those who shoot birds or who foolishly study their remains in museums. No doubt he was acutely embarrassed by these early letters that portray a period in his own life when he was shooting birds for money and when he had stated (p. 54): "As I am fond of gunning, the Duck and Snipe families are favourites." He did his best to leave the letters entombed in the pages of the *Proceedings*, and when, as an old man in 1920, he published the *Birds of La Plata*, he stated that it differed from the earlier *Argentine Ornithology* in that all of Sclater's contributions had been "thrown out."

It will be evident from the above comments that this little volume is intended primarily for those interested in Hudson's literary development and in a glimpse of this particular "artist as a young man." The scholarly comments by West and Dewar are directed to this purpose. In addition, bird students who lack access to Hudson's larger works on the birds of the Argentine will find here many of his more interesting observations on the habits of the birds of that country.

DEAN AMADON

BIRD LIFE.

By Edward A. Armstrong; drawings by E. A. R. Ennion. Oxford University Press, New York (made in Great Britain). $2.50. xii + 152 pp. + 23 pl.; text ill. 1950.

The present volume is somewhat intermediate between the author's more advanced treatise on *Bird Display and Behavior* and his elementary book, *The Way Birds Live*. It provides more detailed information on matters merely touched upon by the latter book, but at the same time remains non-technical in nature. The topics discussed include migration, territoriality, sex recognition, social hierarchy, song, nesting, parental care, and courtship, among others. Those interested in the natural history of bird behavior will find here much material that should help them interpret some of the many activities of birds. Not all interpretations are to be taken at face value, however, as the author has a tendency to be rather uncritical in his use of source material (none of which, incidentally, is cited). A few lapses were noted, such as the statement that the American kingbird's red crown feathers are located near its beak. Likewise the statement that "cuckoos and other parasitic birds all over the world tend to lay eggs so coloured as to resemble the eggs of the bird they victimise" is misleading with respect to our non-parasitic North American cuckoos and erroneous with respect to our parasitic cowbirds. The book is illustrated with plates and drawings that depict some of the behavior under discussion; although one drawing of an American meadowlark unfortunately looks more like an English lark. In spite of some assertions that will be challenged by the critical student, the book remains a useful, popular survey of the broad and complicated field of bird behavior.

HENRI C. SEIBERT

WILD ANIMALS OF FIELD AND FOREST.

By William T. (Bill) Cox. The Farmer, St. Paul, Minn. 25 cents (regular paper); 50 cents (extra heavy cover, plastic binding). 112 pp.; ill. 1950.

BIRD STORIES. *A Collection of the Bird and Wildlife Stories which First Appeared in Bird Stories Nos. 1, 2, and 3 Published by the Farmer Bird Club.*

By William T. Cox and Dietrich Lange. The Farmer, Saint Paul, Minn. 25 cents (paper). 112 pp.; ill. No date.

These booklets contain articles on birds and mammals which have appeared in *The Farmer* over a period of years. Although bearing on no one particular theme, the stories are well told and describe many interesting personal observations. Some good advice regarding wildlife conservation is included. There are numerous illustrations, and the book on birds contains instructions for building bird houses.

HENRI C. SEIBERT

ELEPHANT BILL.

By Lt.-Col. J. H. Williams. Doubleday & Co., Garden City, New York. $3.00. 250 pp. + 32 pl. 1950.

This book is a very delightful account of elephants and the trials, tribulations, and other aspects of the life of their masters who work at hauling the tremendous teak logs in Burmese jungles. It is written by one who spent over a quarter of a century in handling and learning about these remarkable beasts.

DAVID B. TYLER

A KEY TO THE SKULLS OF NORTH AMERICAN MAMMALS.

By Bryan P. Glass. Burgess Publishing Company, Minneapolis. $2.00. iii + 54 pp.; ill. 1951.

Until the publication of this volume there was no single source wherein the skulls of all the genera of North American mammals were diagnosed. Consequently this work will be of immense assistance to practical conservationists, game keepers, ecologists, and students of mammology generally.

The keys are reinforced by drawings, usually a ventral and a dorsal or lateral view of each skull. The majority of these figures were made from actual skulls. The salient and diagnostic features are clearly delineated, the other skull traits merely sketched in. Thus the eye is led at once to the important taxonomic characteristics. The keys themselves have been tested on

students over a 4-year period. There is an excellent bibliography.

The only genera omitted belong to the marine orders Sirenia, Cetacea, and Pennipedia, but the author intends to add them to a later edition. A set of fully labeled figures of a generalized mammalian skull would also increase the usefulness of this future edition for students and for many practical conservationists.

GAIRDNER B. MOMENT

ECONOMIC ZOOLOGY

PIGS *from Cave to Corn Belt.*

By Charles Wayland Towne and Edward Norris Wentworth. University of Oklahoma Press, Norman. $4.00. xiv + 305 pp. + 16 pl. 1950.

The title of this book is accurately descriptive of its contents. It is a history of the porker from the time when the wild boar gored Adonis to death up to recent days when it was found that ACTH could be extracted from its pituitary gland. The pig's roles have been many. In ancient times it was both reviled as unclean, and considered sacred and godlike; in the form of the wild boar, it has always been an adversary worthy of any sportsman; in our own economy it occupies a fixed and important place, with the porker population determined rather exactly by a corn-hog ratio. Its products are likewise varied, for as Lloyd Burlingham states in the preface, "if the packer, utilizing every other part of the pig, has not yet found how to save the squeal, it is the only indignity to which the fabulous porker has not been subjected." The authors, in writing their book, have left no famous pig unmentioned, and no reference uncited from the Bible to the *Breeder's Gazette*, from the *Harvard Classics* to the *Journal of Biological Chemistry*. The result is a highly entertaining volume that at the same time is packed with historical, commercial, and agricultural data. One need not have connections with the animal industry to enjoy this book.

C. P. SWANSON

SWINE PRODUCTION. *McGraw-Hill Publications in the Agricultural Sciences.*

By W. E. Carroll and J. L. Krider. McGraw-Hill Book Co., New York, Toronto, and London. $5.00. viii + 498 pp.; ill. 1950.

The authors have reviewed the place of the swine industry in agriculture in the United States historically and currently. The management, breeding, marketing, and especially the nutrition and feeding of swine are treated for the adult reader. These sections on feeding, nutritive requirements, and the nutritive value of feedstuffs for swine are outstandingly thorough. The book is generally excellent.

There are a few inconsistencies and errors. The authors state (p. 157) that "Only in very rare cases will the boar have any part in determining the number of pigs which results from a given mating." They also say, "It is now well recognized that quality of semen is reflected in the size of litter as well as in the percentage of sows that settle" (p. 159). The caption to figure 27 states that the anemic pig pictured had "1.1 gm. hemoglobin per cubic centimeter when 8–10 gr. is normal."

The authors review briefly the application of genetics to swine breeding. Their review consists principally in a recitation of the difficulties in improvement through breeding and especially the difficulties of cross breeding and the formation of inbred lines of superior combining value. They conclude that "the fact that the possibility of improving the productivity of swine through breeding and selection is so uncertain is no justification for neglecting this phase of the enterprise entirely, but is reason for not spending an undue amount of time and energy in this direction." This may be sound advice for the majority of students of swine production and of swine producers. Few of the competent genetic research workers in swine breeding share the authors' dim views of the probable progress to be made in the improvement of swine through breeding.

T. C. BYERLY

DAIRY CATTLE AND MILK PRODUCTION. *Fourth Edition.*

By Clarence H. Eckles; revised by Ernest L. Anthony. The Macmillan Co., New York. $3.75. xvi + 560 pp.; ill. 1950.

The first edition of this book was written in 1911 by the late C. H. Eckles as a textbook for the college student of dairy husbandry and for the progressive dairy farmer. The present (fourth) edition, revised by E. L. Anthony, Dean of Agriculture, at the Michigan State College, has the same objective. The great increase in factual information concerning cattle and the production of milk since 1911 has necessitated many changes in the organization and content of the text. In several instances the brief treatment of certain subjects in the fourth edition detracts from its value to the college student. If it can be assumed that he will obtain such information in other courses this criticism may not be valid.

The chapters dealing with the origins and descriptions of the various breeds of dairy cattle are interesting and informative. Those sections dealing with the general care, feeding, and management of calves, cows, and bulls supply the basic information which the student of dairy production needs. The areas in which much new and highly technical information has recently become available have not been fully developed, how-

ever. Very little is said about the physiology and biochemistry of milk secretion. The genetic aspects of cattle breeding are given little emphasis in terms of current knowledge. The discussion of several of the important diseases of cattle is not entirely up to date or technically exact. For example, cattle disease specialists prefer the term "brucellosis" to "contagious or infectious abortion." In cattle the specific organism most commonly involved is *Brucella abortus*, and not *Bacterium abortus*. In regard to the treatment of milk fever, the air inflation technique, which is rarely used today, is described in detail. Acetonemia, a relatively common metabolic disturbance, is dealt with in three sentences. Conventional barns and hand milking are described in detail. The less expensive types of barns such as the "loafing" barn or "tramp" shed and the operation of the milking parlor are merely mentioned.

FREDERICK N. ANDREWS

THE WESTERN RANGE LIVESTOCK INDUSTRY. *First Edition. The American Forestry Series.*

By Marion Clawson. McGraw-Hill Book Co., New York. $5.00. xiv + 401 pp.; ill. 1950.

In this book the author considers the biological and economic problems involved in the production of beef cattle and sheep from grasses, weeds, and shrubs on native range. Range land is usually too steep, too dry, too shallow of soil, or otherwise unsuited to the production of cultivated crops. The western range occupies about three-fourths of the area west of a north-south line through the approximate center of the tier of States from North Dakota to Texas. Limited range areas also occur in the Appalachian Mountains, Florida, and other sections of the eastern United States. While the total number of people directly engaged in range livestock production is probably fewer than one million, the political, economic, and nutritional significance of the industry is very great.

Beef cattle and sheep are in a considerable degree supplementary in the types of forage they utilize, although except in the Edwards plateau area of Texas combined cattle and sheep ranches are exceptional. Seasonal and annual rainfall and prices are subject to great variation, so that range production passes through wide fluctuations, sometimes including several successive years of economic loss or of exceptional gain. The average ranch is not a large enterprise. The average cattle ranch has about 200 head, the average sheep ranch about 850. There are, of course, a few hundred very large ranches, and the history of a few is reviewed.

From the biological standpoint, the dominant consideration of the rancher is to get a year-round feed supply for as many animals as possible at the lowest cost. Favored areas in the Southwest and northern Great Plains furnish year-round grazing. In most areas dry-land or irrigated forage crops, especially alfalfa, are essential to range livestock production. Hay is expensive because of the labor required, both for harvesting and feeding. Economical ranch operation involves the minimum use of hay consistent with maintenance of the productivity of range lands and safety of livestock operations.

With respect to rate of stocking, the author concludes that the most economical rate is usually the heaviest which will maintain the productivity of the range unimpaired. Agreement on this general proposition is easy, but adequate criteria for predicting range impairment are rather less than perfect.

The book contains a good many economic analyses unhampered by data. Many of the data which are presented are of historic interest only. Data for the past 10 years, a period of unusual interest and rapid change, are treated separately.

T. C. BYERLY

PARROT FAMILY BIRDS—*Their Training, Care and Breeding. Chapters on Talking Birds: European Starling, Crow Family, Hill Mynahs and Magpies.*

By Julien L. Bronson. All-Pets Magazine, Fond du Lac, Wis. $2.00. 96 pp.; ill. 1950.

This book is addressed to the person interested in raising parrots and their allies. It provides the necessary information for the proper housing, feeding, and care of these birds. Types, construction, dimensions, and uses of pens and cages, diets, grooming, teaching to talk, and all other essentials of parrot-raising are included. The different kinds of parrots, parrakeets, lorikeets, lories, loriquets, love birds, pigmy parrots, cockatoos, cockatiels, macaws, shell parrakeets, caiques, and conures are briefly described or mentioned. Each is evaluated as a pet or as a talking bird. Scientific names are appended, and as would be expected in a work of this nature, several errors occur: thus, the Kakatoeinae are regarded as a family; among specific names, *jenkeri* for *zenkeri*, *nigrigensis* for *nigrigenis*, *alliceps* for *palliceps*, and others. These errors being mostly in the nature of misspellings which can be easily rectified. Their presence is overcompensated by having scientific names available for identification purposes. Included with the parrots are mynahs, magpies, crows, and others that have or are believed to have the ability to talk. Lice, mites, broken appendages, septic enteritis, egg binding, and other disturbances of parrots, as well as methods of preventing or combatting them, are accorded mention. The writer feels that much "stupid" publicity has been given to psittacosis, which he considers as a very minor disease. Aureomycin and chloromycin are regarded as promising agents against psittacosis, although the results on which these conclusions are based have not

yet been published. Drawings and photographs depict some of the birds mentioned.

HENRI C. SEIBERT

STROUD'S DIGEST ON THE DISEASES OF BIRDS.

By Robert Stroud. Published by L. G. Marcus and Robert Stroud, [distributed by All-Pets Magazine, Fond-du-Lac, Wis.]. Minneapolis, Minn. $5.00. x + 500 pp.; ill. 1943.

This most remarkable publication is an alphabetically arranged compendium of available knowledge on bird diseases, with avian anatomy, physiology, pharmacology, and related fields thrown in. It is intended as a source book of information for the practicing poultry man or for anyone who handles caged birds. It includes a considerable number of pathological conditions and it is unlikely that any reasonably common disease, injury, or abnormal manifestation in the lives of birds has been omitted. A major difficulty in presenting any such material is to organize it in such a way that the uninitiated person can locate and identify a disease whenever a bird in his care has developed certain symptoms of distress. The alphabetical method does not appear to be the best, although numerous cross references are a great help.

Being privately printed, the book has considerable freedom of expression which, to say the least, can be viewed with mixed emotions. The writing is lucid, even though the writer goes out of his way to profess his lack of formal education. Unfortunately, he seems to bear a grudge against the veterinary profession and lashes out in exceedingly vivid statements at veterinary science, veterinarians in general, and some veterinarians in particular. Pages 235–236 are taken up with a personal rejoinder. Characteristic is a note to breeders (p. 233): "You are not supposed to understand this paragraph. It is included for the benefit of some of my scientific friends and really does not mean anything of importance." Such statements merely reflect on the writer and tend to produce an undervaluation of his competence. The illustrations were made by the writer and vary from poor (especially those drawn from memory) to acceptable. Yet for all such flaws the heart of the material is generally satisfactory and should prove useful.

In many places, however, over-optimism pervades the treatments. A footnote on p. 49 is an example: "This fact does not say much to the credit of the veterinary profession, since the disease [bacillary white diarrhea] is purely a septicemia and should not be hard to cure. Given sufficient experimental material, if I could not cure it in a year I would be heartily ashamed of myself. I feel so certain of this that I would be willing to gamble my life on the outcome." Such confidence cannot readily be dismissed.

HENRI C. SEIBERT

FISHING IN MANY WATERS.

By James Hornell. Cambridge University Press, New York and London. $6.00. xvi + 207 pp. + 36 pl.; text ill. 1950.

With so many books on angling appearing in these days, and with most of them of such indifferent value, one is tempted to look no farther than the title of this book. This would be a misjudgment, for it turns out to be something quite different from the usual run of reminiscences about the big ones that got away. The late James Hornell was interested in odd ways of catching fish and in primitive fishing economies. As a member of various fishery missions for the Colonial Office, he was able to observe at first-hand many of the methods he describes, particularly in Africa, India, and the South Seas. He was also handy with his camera, and the photographs which illustrate this volume are excellent. Thus we have a book of interest to anthropologists as well as to anglers with a scholarly bent. It does not seem possible that the author could have been unaware of his most worthy predecessor, Radcliffe's *Fishing Since Earliest Times*, and its omission from the bibliography must be due to the author's untimely death. This seems to be the only oversight in a book which is entertaining as well as instructive, from which one may learn such useful methods as fishing with kite and spider webs, catching octopus with pelican foot shells, and angling for catfish with cockroaches.

JOEL W. HEDGPETH

HANDBOOK OF FRESHWATER FISHERY BIOLOGY.

By Kenneth D. Carlander. Wm. C. Brown Co., Dubuque, Iowa. $4.50. vi + 281 pp. + 2 folding charts. 1950.

This book summarizes, in tabular form, the number of fish, their ranges and average lengths and weights, in other words, the bare data, of several hundred studies of freshwater fish in North America. This tabular matter occupies 220 pages, and the bibliography 40 pages, of the total of 281 pages. While such a summary is probably useful to specialists, the title is misleadingly ambitious.

J. W. HEDGPETH

ANIMAL GROWTH AND DEVELOPMENT

A CLASSIFIED BIBLIOGRAPHY OF GERONTOLOGY AND GERIATRICS. *Prepared for Stanford University under a grant from the Forest Park Foundation, Peoria, Illinois. By Nathan W. Shock. Stanford University Press, Stanford, Cal.* $15.00. xxviii + 599 pp. 1951.

Although the study of aging has become a subject of major importance within the last decade, it has not

until recently been prominent enough to attract adequate bibliographic attention. In 1947, however, Dr. Nathan W. Shock, Chief of the Section on Gerontology of the National Heart Institute, undertook the formidable task of searching out and classifying all material on aging published throughout the world up to that time. How formidable the task was may be judged by the briefest examination of the result, a 3½ lb. quarto volume with 18,036 entries arranged in closely printed double columns.

Beginning with general papers for orientation, the book proceeds through the Biology of Aging, Organ Systems, Geriatrics, Psychological Processes, and Social and Economic Aspects. Each major heading is then broken down to several levels of subsections. This intensive breakdown, coupled with liberal cross-references and an excellent index, makes the book a pleasure to use. Granted even a reasonably clear idea of what one is looking for, the appropriate references are found easily and without trouble.

The articles listed have been drawn from nearly 2300 journals. Books are included too, the total content spanning the whole distance from Aristotle to Cowdry. The material was gathered by searching all the standard series of abstracts and indices, and also by examining the private bibliographies of leading workers in the field. In order to avoid missing papers in which the word "aging" did not appear in the title, every abstract was read in *Biological Abstracts*, *Social Science Abstracts*, *Psychological Abstracts*, and the *Population Index*.

At a time when gerontology is attracting ever wider attention, this bibliography not only fills a real need, but does it in an admirably competent and thorough fashion. From every one who is now contemplating the challenging problems of the aging process, Shock and his sponsor, the Forest Park Foundation, deserve the warmest thanks.

FLORENCE MOOG

ANIMAL MORPHOLOGY

THE CHORDATES.

By Herbert W. Rand. The Blakiston Co., Philadelphia and Toronto. $6.00. xii + 862 pp.; ill. 1950.

The Chordates deserves to occupy a preeminent place among standard textbooks on comparative anatomy. In this book Rand has accomplished a truly herculean task. Within the limits of 395 pages are incorporated the essential facts and principles of comparative morphology and classification of the chordates. The balance (467 pages) comprises sections devoted to related topics, including general features of vertebrate morphology, histology, embryology, and evolution, as well as a thoughtful and scholarly discussion of the aims and general methods of comparative anatomy. The organization of the main parts of the book and also of chapters within these parts is logical and wholly adequate. The organization of the book as a whole reflects the expenditure of much thought and care in its planning. Implementation of the author's objectives according to his plan has been accomplished in a generally scholarly and thorough manner. The style is easy and readable.

The considerations which led the author to undertake writing this book are outlined in the Preface. One of the strongest of these, apparently, was the fact that beginning students of comparative anatomy in general, at least in the larger universities, are unable to do very much collateral reading to supplement their heavy schedule of lecture and laboratory instruction. A principal aim of the present book, accordingly, is to provide within a single volume a large body of information to supplement the usual subject matter of comparative morphology. In this one book, therefore, there is available to the student not only the conventional information but much of what is often neglected.

The 3 main parts into which this book is divided are: Part I, Basic Structure of Vertebrates; Part II, Comparative Anatomy—Its History, Aim and Method; Part III, Comparative Morphology of Chordates. The last part is organized by classes and a classification of each class is given.

A book of this kind necessarily owes much of its eventual success or failure as a tool for teaching and learning to the adequacy of its illustrations. In this respect, *The Chordates* is far more than merely adequate. Not only is it profusely illustrated, but the illustrations are uniformly excellent in appropriateness, form, and reproduction. Particular mention should be made of the many excellent diagrams which should prove a valuable aid to the student in interpreting descriptions in the text. The format generally is excellent. There is an index but no bibliography.

MAX KRAUSS

ATLAS OF HUMAN ANATOMY. *New Revised Edition. With section on the Endocrine Glands.*

By Franz Frohse, Max Brödel, and Leon Schlossberg. Explanatory Text by Jesse Feiring Williams; descriptive text by Charles F. Geschickter; illustrations by Leon Schlossberg; edited by M. F. Ashley Montagu. Barnes & Noble, New York. $2.75. 88 pp.; ill. 1950.

This small volume is a rather strange mixture of superb, detailed anatomical plates in color, very poorly reproduced drawings of various endocrine tissues in halftone, and a clear and reasonably accurate but very elementary text. For the advanced student the text will be completely superfluous beside his anatomy and histology textbooks; for the elementary student the beautiful plates which form the heart of the volume are

far too crowded with detail. A much better book could have been prepared had the needs of a particular category of users been kept consistently in mind.

The color plates include 27 of the famous Frohse-Brödel charts, with further additions by Schlossberg, who worthily carries on the tradition of his master. Reduction to a page only 8¼ x 5½ inches, or a portion thereof, makes it necessary to use a lens to bring out the detail with clarity. If the publishers would enlarge the size of the figures and provide a text limited to the necessary explanation of the plates, the value of the book would be greatly enhanced.

BENTLEY GLASS

ATLAS OF HUMAN ANATOMY FOR THE ARTIST.

By Stephen Rogers Peck. Oxford University Press, New York. $6.00. xvi + 272 pp.; ill. 1951.

In answer to the question, "How much anatomy must an artist know?"—this book is the answer. It is a well constructed bridge which correlates beautifully the complexities of human architecture with the hard and fast rules of sheer artistic technique. It assumes that the reader is thoroughly familiar with the basic concepts of line, form, shadow, action, etc., and that therefore it is not necessary to teach him figure drawing. This book has selected many of the salient mechanical and structural features of the human body, and presents them clearly and simply. The reader may feel assured that practically all things it is necessary to understand in order to draw the human form are incisively and colorfully discussed. Much material is presented here for the first time as a part of the artist's armamentarium, e.g., facts about the skin, hair, types of build, equilibrium, locomotion, and facial expression. There are photographs, sketches, and diagrams.

This book would be extremely useful as a preliminary textbook for students of medical illustration, since it gives a clear, practical understanding of the body as a whole, and the chance that a student will "miss the forest for the trees" should be minimized. The book embraces its subject beautifully. There is nothing extraneous and practically nothing further to be desired. It is highly technical material so presented that it will be read with story book enthusiasm.

WILLIAM E. LOECHEL

HUMAN ANATOMY AND PHYSIOLOGY. *Third Edition.*

By Nellie D. Millard and Barry G. King. W. B. Saunders Co., Philadelphia and London. $4.25. xii + 596 pp.; ill. 1951.

This book offers a logical and progressive study of human anatomy for nurses and other medical technical groups. The illustrations are clear and numerous. Each is directly labeled in English and some are in color. Each chapter is provided with a valuable summary and a set of discussion topics for the student. An excellent index occupies 37 pages.

JOHN A. CAMERON

FUNCTIONAL ANATOMY OF THE LIMBS AND BACK. *A Text for Students of Physical Therapy and Others Interested in the Locomotor Apparatus.*

By W. Henry Hollinshead. W. B. Saunders Co., Philadelphia and London. $6.00. viii + 341 pp.; ill. 1951.

Classes in physical therapy should be grateful to the above author, for he has done a superior piece of work in omitting much and in clearly presenting a great deal. The illustrations are simple, clear, and well labeled without overcrowding. In addition to the regions mentioned in the title, there are adequate chapters treating of the head, neck, and trunk as dealt with by the physiotherapist. Most anatomists can profit by reading this book for its style and manner of presentation of material.

JOHN A. CAMERON

ELECTRON MICROSCOPIC HISTOLOGY OF THE HEART. *An Application of Electron-Microscopic Research to Physiology.*

By Bruno Kisch, in collaboration with Joan M. Bardet. Brooklyn Medical Press, New York. $5.50 (paper). viii + 106 pp.; ill. 1951.

This work, comprising several published papers, is an attempt to study the heart as a tissue by means of electron microscopy. Because of the somewhat basic anachronism involved in covering such a wide field with a remarkably restrictive instrument, the purposes of the study are fulfilled in only a limited degree. The myocardial fibrils are revealed as non-syncytial filaments connected with each other only by Z bands. These show characteristic shortening of the zone between the Z bands upon contraction. Between the fibrils in spaces formed by the Z bands lie roughly spherical bodies called sarcosomes which are believed to be enzyme carriers. Additional details are less well documented.

The authors suggest possibilities for physiological and pharmacological studies, but better whole tissue preparations are needed before too much validity can be given to their interpretations. They believe, for example, that capillaries penetrate the cell membranes. This would appear to be a dangerous deduction on the basis of the study of isolated sections containing gross artefacts and limited detail. The presentation is interesting and stimulating in a very difficult and demanding field, but unfortunately barely begins to ex-

plore the application of the unique high magnifications of the electron microscope.

E. CONVERSE PEIRCE, 2ND

PRINCIPLES OF OPHTHALMOLOGY.

By Thomson Henderson. Grune & Stratton, New York (printed in Great Britain). $4.50. 230 pp. + 14 plates; text ill. 1950.

The author presents in this pleasantly argumentative book the results of his lifelong studies of certain ophthalmologic problems. Part I concerns chiefly the variation in degree of divergence of the visual axes in the eyes of different mammals and the asymmetries of the eyeballs in these species. This section is replete with valuable information regarding the comparative anatomy of the mammalian eye. Parts II and IV deal similarly with the comparative anatomy of the angle of the anterior chamber. It is the author's contention that the aqueous humor gains access to the suprachoroidal space, and that absorption of fluid via the suprachoroidea rather than via Schlemm's canal is the important element controlling intraocular pressure. The anatomical evidence presented in the cause of this argument is valuable and interesting. Failure to buttress the argument by physiological experiments, however, robs it of conclusive force. Part III concerns the mechanism of accommodation, and Part V, the mechanism of glaucoma, in regard to both of which the author has interesting and heterodox notions.

JONAS S. FRIEDENWALD

THE CEREBRAL CORTEX OF MAN. *A Clinical Study of Localization of Function.*

By Wilder Penfield and Theodore Rasmussen. The Macmillan Co., New York. $6.50. xvi + 248 pp.; ill. 1950.

ESSAY ON THE CEREBRAL CORTEX. *A Monograph in American Lectures in Anatomy. Publication number 59, American Lecture Series.*

By Gerhardt von Bonin. Charles C. Thomas, Springfield, Ill. $3.75. xiv + 150 pp.; ill. 1950.

The work of Wilder Penfield and his colleagues and students at the Montreal Neurological Institute has been for many years of exceptional interest to the medical world, and especially to students of nervous activity. However, a great debt of gratitude is owed the Lane Lectureship (of Stanford University) for having provided a stimulus, the ultimate response to which was the publication of this remarkable book—a summary of 20 years of the keenest observation, study, and analysis of the human brain. Often, observations in man have not supported earlier physiological studies, the latter, in many instances, having later been shown to have been in error. Such disagreements are also to be found in the present case, as well as agreements with the previous findings and new data not hitherto reported in animals (primarily because of our inability to intercommunicate). With the consent of their patients, the authors have investigated the cerebral cortex of man by means of direct electrical stimulation (with and without warning), while the patient was under local anesthesia. Consequent to the careful probing of the cortex in hundreds of cases, they have been able to present here their observations relative to sensorimotor, autonomic, visual, and auditory centers, as well as to memory, sensory perception, and dreams. Finally, they have been led to suggest a new point of view from which to consider the function of the cerebral cortex and its relation to the integrated activity of the nervous system.

Physiologists, neuroanatomists, neurosurgeons, and neurologists unquestionably will find in this report a mass of factual information of inestimable value to their work. Although this will also hold true to a certain extent for the psychologist and psychiatrist, it will be of further interest to them to note that the properties of will, reason, and emotion still remain the most elusive, having resisted even these superlative efforts to localize them. To be sure, the neurologists, too, will find that cortical stimulation cannot answer all their questions yet. One example of this, pointed out by the authors, is that "the movements produced by cortical stimulation are never skilled, acquired movements, but instead consist of either flexion or extension of one or more joints, movements which are not more complicated than those the newborn infant is able to perform." Physiologists will be most interested to know that no evidence for the presence of a suppressor strip, 4s, could be found by these investigators. This point is particularly intriguing in the light of other recent physiological studies in which the same difficulty was encountered. The authors also report an area from which bilaterally synergic movements may be produced. This is called the supplementary motor area, to distinguish it from the classical sensorimotor area and the secondary sensory and motor representation. It is situated within the superior intermediate frontal region within the longitudinal fissure.

Some of the more unusual observations reported have to do with sensory perception (including what the authors term "ego scrutiny"), dreams, and memory. "We have stumbled unexpectedly upon the location of the neuronal patterns 'which dreams are made of' and have glimpsed other mechanisms within the humming loom of the mind." Epileptic hallucinations reproduce remembered events, and it is felt from stimulation experience that these induced mental states are like dreams. Epileptic discharge appears to condition the temporal cortex so that electrode stimulation can reproduce "the same chain of neuronal activity." "It is not a picture or a single sound, but a progressive changing psychical phenomenon." The

authors feel further that in these instances the electrode stimulus is activating, patterns involved in the mechanism of memory—a mechanism in which the two temporal lobes have equal value. On the basis of the experimental opportunities which disease, epilepsy, and stimulation have offered, 4 major areas of the cortex are described. It appears to the authors that "the various functional areas of the cerebral cortex play, each of them, an integral role in the activity of what might be called the different departments of the diencephalon." Once again, this classic work, following that of Pavlov and Hughlings Jackson, draws attention to subcortical centers which may provide the mechanisms for the coordination of function of the cortical areas, and may ultimately help to explain some of the mental phenomena which have, for so long, been placed beyond the realm of the neurophysiologist.

Von Bonin's essay "endeavours to give that factual information about the cerebral cortex which can be applied to an analysis of its function, but to avoid overburdening the reader with a plethora of minutiae." In this he has succeeded. Following a brief theoretical and phylogenetic introduction, the general morphology of the cortex is described. With this as a background for the reader, an attempt is made to make some interpretations of cortical function, divided into four areas: sensation, action, prediction, and emotion. The presentation is throughout of the scholarly nature we have learned to expect from this author, who has integrated information in many fields in this attempt to understand cortical function. However, he too, like Penfield and Rasmussen, finds himself facing certain unanswerable questions; but in dealing with them, he appears willing in many instances to go further in accepting many currently popular theoretical concepts that have as yet very little actual data to support their validity. In many cases he has attempted to make a necessary and interesting correlation of detailed cortical morphology and the ancillary functional pictures. It is, however, not too surprising that many times there seems to be little of the finer structure that can be tied together with even the grosser functions. One wonders how far attempts of this nature can lead us toward integration, when confronted with the relatively meager new information such studies afford. Perhaps it would be more rewarding if the morphological studies were of a cytochemical nature and essayed to clarify the chemical structures involved and their relations to integrative activity.

The section on the anatomy of emotion points out that two cortical regions are in direct connection with hypothalamic centers—centers which are affected by emotional states. One is said to be the frontal lobe, although many still feel that the evidence for such connections is equivocal. The second possibility has been very neatly reconstructed so as to introduce the concept of reverberating circuits. In the author's words: "Starting from the hypothalamus—we can follow impulses via the mammillothalamic bundle to the anterior nucleus of the thalamus, thence by its radiation to the cingular or limbic sector, thence into the cornu ammonis, and from there by way of fimbria and fornix back again to the mammillary bodies. There is thus a large reverberating circuit—in which neuronal activity could be maintained in a steady state over long periods and which has ample connections with the rest of the cortex." Von Bonin goes on to make a most important observation, namely, that to state that the hypothalamus is the seat of emotion means nothing; "the epistemic correlates of emotion are neuronal events in circuits, not a specific state of any one group of cells." This concept is most interesting in the light of the question as to what role (if any) the phenomenon of autorhythmicity might play in these events.

The essay, in general, will be extremely stimulating to all those interested in neuronal activity and behaviour. Both these books have obviously received extreme care in publishing—print and illustrations are in each case first rate.

R. G. GRENELL

ANIMAL PHYSIOLOGY

A WORKBOOK FOR THE STUDY OF HUMAN PHYSIOLOGY. *By James R. Burkholder. Pacific Books, Palo Alto, Calif.* $2.50. 224 pp.; ill. 1949.

In many institutions of college level, enrollments have increased to such a point that facilities for laboratory instruction for all students of the biological sciences are no longer adequate. This workbook, made to be used with *The Living Body*, by C. H. Best and N. B. Taylor, replaces the customary laboratory manual. It contains brief discussions, problems to be solved, questions to be answered, materials for drill and testing, etc. As such, it seems to be a thorough and useful adjunct to teaching human physiology on the elementary level. The grave question is not that of the merits of any individual workbook, but whether, even for the non-science major, a course without some laboratory experience is a desirable type of course. It would be interesting to know what proportion of college biology courses are now given without any laboratory work. So far as I know no survey to answer the question has been made recently. Nor is there any consensus regarding the effectiveness of non-laboratory courses, compared with courses in which various amounts of laboratory work are given. Particularly in the field of general education, as contrasted with preprofessional work, the matter needs attention.

BENTLEY GLASS

TEXTBOOK OF PHYSIOLOGY AND BIOCHEMISTRY. *By George H. Bell, J. Norman Davidson, and Harold Scarborough; foreword by Robert C. Garry. Williams*

& Wilkins Co., Baltimore. $9.00. x + 918 pp. + 124 pl; text ill. 1950.

If one merely scans this book, it becomes obvious almost immediately that it is not, as the title claims, a textbook of physiology and biochemistry. It is an introductory survey of the physiological and biochemical bases of clinical medicine, for medical students. Whether or not this sort of thing is good for medical students is a point often discussed. One certainly need not be averse to altering—even radically—medical school curricula, in order to further the integration of the preclinical and clinical sciences, but is very doubtful that anything is to be gained from the superficial sort of integration manifested by a book like this one. Integration which eliminates scholarliness and stimulation of thinking is not of any value. The authors of this textbook have seen fit to omit controversial questions which might make medical students "nervous"—not to mention thoughtful. No student finishing the book would be impressed with what he *didn't* know!

Neither is recent research in many fields discussed—in fact, it is a little startling, in a British textbook, to find in the sections on the nervous system, no mention of (nor reference to) the work of Hodgkin. There is no discussion of fundamental physiological problems such as ionic transport, or other permeability factors, hemodynamics, etc. The bibliography is far from complete—there is a remarkable lack of references to recent important literature.

It can only be hoped that despite the tendency of many medical students to hasten to purchase books that they feel are either "outlines" or are "clinical," the majority of students will still be aware of the existence of such textbooks of physiology as those by Starling, McLeod-Bard, etc.

R. G. GRENELL

THE THYROID.

By Thomas Hodge McGavack; section on surgery by James M. Winfield and Walter L. Mersheimer; section on history by Dorothy B. Spear and Thomas Hodge McGavack. C. V. Mosby Co., St. Louis. $13.50. 646 pp.; ill. 1951.

T. H. McGavack, for many years one of the outstanding students of thyroid disease, has summarized our present knowledge of the thyroid in this interesting book. In an introductory section written in conjunction with Dorothy M. Spear, he reviews the historical aspects of the thyroid problem. The historical development of thyroid physiology and pathology is a fascinating story, and is well told. The next section deals with anatomical, chemical, and physiological considerations. One may disagree with the statement that "the fundamental function of the thyroid hormone is the regulation of the rate of energy exchange or metabolism," since comparative physiologists feel that the thyroid gland in the lowest vertebrates is concerned primarily with growth and maturation and only secondarily with energy exchange. The chemistry and pharmacology of the antithyroid compounds is discussed with great clarity. The chapter on the radioactive isotopes of iodine reviews recent advances in this field. It might be advisable either to expand or to omit the introductory paragraphs of this chapter, since it seems to be impossible to give the necessary background of nuclear physics within 6 pages.

The chapters on thyroid disease in the adult reflect the author's great clinical experience, but the chapter on cretinism will be open to criticism by pediatric endocrinologists. The roentgenologic appearance of the bones of cretins is neither adequately described nor illustrated, although epiphysial dysgenesis (Wilkins) is probably the most specific of all anatomic signs found in cretinism. Most pediatricians will find the dosage of thyroid extract recommended for the treatment of the cretinous infant not wholly adequate. These are, of course, minor points and do not detract from the value of McGavack's treatise. The book is well printed, and numerous references and illustrations enhance its value.

WALTER FLEISCHMANN

CHLOROFORM. *A Study after 100 Years.*

Edited by Ralph M. Waters. University of Wisconsin Press, Madison. $2.75. xvi + 138 pp.; ill. 1951.

It is very fitting that with modern technics on both laboratory animals and patients, the use of chloroform as an anesthetic agent should have been reinvestigated. Chloroform is not extensively used as an anesthetic in this country and its reevaluation in this volume as an anesthetic agent is a welcome addition to our knowledge in anesthesiology. The authors have studied the effect of chloroform on hepatic function, renal function, and the cardiovascular system, and have also compared it clinically with other more generally used anesthetics. The chloroform content of the blood and respired air during anesthesia has been investigated. Specific conclusions have been drawn, and it appears from the experiments recorded here that chloroform does not deserve to be abandoned as a surgical anesthetic. The authors found that its hepatic and renal actions compare favorably with those of other anesthetics. However, the effect upon the cardiovascular system in these studies was found to be less favorable than with other anesthetic agents. The untoward effect of chloroform was mainly upon the heart itself and not upon the blood vessels. The authors point out that under chloroform anesthesia there is ever present the possibility of causing either reflex or direct myocardial depression which may progress rapidly to cardiac arrest. The entire volume will stand as a suitable milestone

in our knowledge of the effect of chloroform as an anesthetic agent.

JOHN C. KRANTZ, JR.

IMMUNOLOGY LABORATORY EXERCISES.
By Robert A. West, Jr. Burgess Publishing Co., Minneapolis. $2.00 (paper). ii + 96 pp. 1950.

This manual is intended to give adequate laboratory directions for a first course in immunology with a minimum of supervision by the instructor. It is arranged in five main groups of exercises. These are a bacterin series with 12 exercises, a precipitin series with 5 exercises, a hypersensitivity series with 3 exercises, and a toxin and toxoid series with 2 exercises. There are 3 supplemental exercises, which include preparation of a McFarland nephelometer, skin tests and immunization, and the Paul-Bunnell test.

The presentation of each exercise follows a uniform plan which should facilitate their use by student and instructor. On the whole, the exercises are well-chosen and should serve to acquaint the student with many of the basic procedures and techniques of immunology. There are no exercises on complement and complement fixation, blood typing, drug sensitization, and various other phases of immunology. These omissions are noted by the author, who believes that those topics may better be studied in a beginning course as supplementary exercises.

MAX KRAUSS

ANIMAL NUTRITION

BIBLIOGRAPHY OF THE LITERATURE ON THE MINOR ELEMENTS AND THEIR RELATION TO PLANT AND ANIMAL NUTRITION. *4th Edition. Vol. II.*
Compiled and published by the Chilean Nitrate Educational Bureau, New York. iv + 152 pp. 1951.

The 4th edition of volume II brings the abstracted literature on the minor elements up to December, 1950. As in other editions, each article is briefly summarized, and cross-referenced by means of author, element, general nutrition, and botanical nutrition indices. The abstracts total 1,222 different articles.

ADVANCES IN FOOD RESEARCH. *Vol. III.*
Edited by E. M. Mrak and George F. Stewart. Academic Press, New York. $9.50. xii + 518 pp.; ill. 1951.

The steadily increasing application of the chemical, physical, and biological sciences to the solution of the numerous problems in food technology has resulted in a great number of scientific papers published in numerous journals, and has necessitated the publication of this series of annual volumes. The present volume, of the high standard set by former ones, will be found highly informative not only to food technologists, but to investigators in other fields as well. There are chapters on the following subjects:

Enzyme-Catalyzed Oxidative Browning of Fruits (M. A. Joslyn and J. D. Ponting); Physical and Chemical Aspects of the Production, Storage and Utility of Dry Milk Products (S. T. Coulter, Robert Jenness, and W. F. Geddes); Electro-magnetic Radiation Fundamentals and their Applications in Food Technology (Bernard E. Proctor and Samuel A. Goldblith); The Pharmacological Evaluation of Antioxidants (A. J. Lehman, O. G. Fitzhugh, A. A. Nelson, and G. Woodard); *Salmonella* Infection as a Food Industry Problem (W. R. Hinshaw and Ethyl McNeil); Reaction between Sugars and Nitrogenous Compounds and their Relationship to Certain Food Problems (J. P. Danehy and W. W. Pigman); Chemical and Microbial Studies on Sliced Canned Bacon (John A. Ulrich and H. O. Halvorson); Certain Aspects of Internal Corrosion in Tin Plate Containers (R. R. Hartwell); Rationale for Studies of Consumer Food Preferences (Richard L. D. Morse); and Control of Microorganisms Causing Spoilage in Fruits and Vegetable Products (Mathilde von Schelhorn). The extent to which original scientific publications are given attention is shown by the fact that collectively the chapters are followed by more than 1500 references to original sources of information.

E. V. MCCOLLUM

VITAMIN METHODS. *Vol. II.*
Edited by Paul György. Academic Press, New York. $14.50. xii + 740 pp.; ill. 1951.

Like its predecessor (see *Q.R.B.*, 26: 226. 1951), Volume II is a valuable compendium of vitamin methodology. It is devoted to a consideration of animal assays and their clinical appraisal, and contains the following chapters: General Aspects of Small Animal Experimentation (N. B. Guerrant); The Animal Vitamin Assays (C. I. Bliss and P. György); Laboratory Diagnosis of Human Vitamin Deficiencies (J. H. Jones); Clinical Signs of Malnutrition (N. Jolliffe); and Statistical Methods in Vitamin Research (C. I. Bliss). The supplement contains brief addenda to several of the articles published in Volume I: Physical Methods of Vitamin Assay (E. T. Stiller); Chemical Methods of Vitamin Assay (P. György, S. H. Rubin, and E. de Ritter); and Microbiological Methods in Vitamin Research (L. D. Wright, H. R. Skeggs, S. H. Rubin, and E. de Ritter).

As far as one can see, there are no important topics in the field of vitamin assay left unanswered by these two large, thorough, scholarly volumes. With periodic supplementation to take care of new developments, these books should for a long time be "primary standards" in their field.

ARTHUR W. GALSTON

VITAMINAS: *Métodos de Dosificación.*

By Gilberto G. Villela; prologue by Venancio Deulofeu. Librería y Editorial "El Ateneo," Buenos Aires. $34.00 (cloth); $28.00 (paper). xvi + 422 pp.; ill. 1948.

This book on vitamin assay methods, published in Spanish, comprises an introductory statement of general methods, and 15 additional chapters, one devoted to each of the best known vitamins. Each chapter covers a rather wide territory: structure, properties, history, biosynthesis, metabolic fate and function of the vitamin, effects of avitaminosis, human requirements, and values encountered in food stuffs and in the body fluids of normal and pathological subjects. As a consequence, the author runs the risk of displeasing both the beginner, who may be unable to evaluate all the information offered, and the initiated, who may find the account uneven and short of its goal. Of all interests, those of the clinician seem to be most consistently kept in mind throughout the book.

Reputable chemical, physical, microbiological, and animal methods of vitamin assay are presented, covering the literature up to 1946, and enriched by the author's experience at the Instituto Oswaldo Cruz (Rio de Janeiro, Brazil). Descriptions are quite explicit, so that those unfamiliar with the techniques should have no difficulty reproducing them. The particular problems presented by the various materials to be assayed are discussed, and special techniques are outlined. Considering that this is intended as a reference work, the organization and the subject index leave room for improvement.

JOSÉ LUIS REISSIG

CURRENTS IN NUTRITION. *Proceedings of the Nutrition Symposium Held at The University of Illinois, College of Medicine, Nov. 19, 1949. Nutrition Symposium Series, No. 2.*

By Bertha Burke, William J. Darby, L. Emmett Holt, Jr., M. K. Horwitt, Ancel Keys, Carl V. Moore, James M. Strang, and R. W. Vilter. National Vitamin Foundation, New York. $1.00 (paper). iv + 128 pp. 1950.

NUTRITION FRONTS IN PUBLIC HEALTH. *Proceedings of a Symposium held at Yale University, Nov., 1950. Nutrition Symposium Series, No. 3.*

By Icie G. Macy, B. H. Ershoff, Clive M. McCay, Ernst Simonson, Howard S. Schneider, and Leo T. Samuels. The National Vitamin Foundation, New York. $1.50 (paper). 168 pp. 1950.

Symposium No. 2 contains papers on the following subjects: Studies on the Thiamine Requirements in Man (M. K. Horwitt); Studies on B Vitamin Requirements of Infants (L. Emmett Holt, Jr.); Pyridoxnei Deficiency Syndrome in Man Precipitated by Low B Complex Diet and Desoxypyridoxine (R. W. Vilter); Maternal Nutrition and Other Factors of Importance to the Fetus and Mother as Shown by Dietary Histories (Bertha Burke); The Newer Hematopoietic Vitamins (Wm. J. Darby); Iron Metabolism and Hypochromic Anemia (Carl V. Moore); The Problem of the Evaluation of Obesity and its Significance (Ancel Keys); and Comments on Some Problems of Obesity (J. M. Strang).

Symposium No. 3 contains: Nutrition and Maternal Health (Icie G. Macy); Factors Conditioning the Development of Malnutrition (B. H. Ershoff); Nutrition as a Factor in Aging (Clive M. McCay); Influence of Nutrition on Work Performance (Ernst Simonson); Nutrition and Resistance—Susceptibility to Infection (Howard A. Schneider); and Nutritional Factors and Hormones in Stress Reactions (Leo T. Samuels). The discussions which followed each paper are included.

PERSPECTIVES IN HUMAN MALNUTRITION. *A Contribution to the Biology of Diseases from a Clinical and Pathological Study of Chronic Malnutrition and Pellagra in the African.*

By Joseph Gillman and Theodore Gillman. Grune & Stratton, New York. $18.00. xxii + 584 pp.; ill. 1951.

The Gillman brothers have distinguished themselves in clinical investigations of extreme states of human malnutrition. Nowhere does malnutrition due to multiple deficiencies of diet occur in such severe forms and afflicting such large numbers of people as among the native (negro) population of South Africa. It is of the pellagra type, but the dietaries of many of the patients which they describe obviously, over prolonged periods, provided less than the minimum requirements of so many of the 40-odd known indispensable nutrients, that the breaks in the concatenated chemical processes which constitute the metabolic scheme were so numerous that restoration of normal metabolism was impossible even when a diet of superior quality was provided, or at least when those nutrients which were judged by clinical symptoms to be primarily responsible for the patient's condition were made available.

The book contains a great deal of information which has hitherto been unknown to many clinicians and biochemists who devote themselves to nutrition research and its problems, and should be read by all who interpret experimental data or who write about or teach nutrition, for it will be found informative, even to many who now speak authoritatively on nutrition subjects. The authors command our admiration for their devotion through many years to the study of a nutrition problem which stems from the inhumanity of a politically dominant race toward a subjugated one, and in bringing it to the attention of the world. It is to be regretted that they have overloaded the volume with much irrelevant discussion and with pronouncements

which will be unacceptable to nutrition investigators who are well informed in biochemistry, physiology, and pathology. Their vigorous criticism of the prevailing tendency of writers on nutrition to over-simplify the subject, is commendable.

E. V. McCollum

THE NUTRITIONAL IMPROVEMENT OF LIFE.

By Henry C. Sherman. Columbia University Press, New York. $3.75. xii + 270 pp. 1950.

The newer knowledge of nutrition is now well established on sound scientific principles, but dietary habits and economic pressures throughout the world have considerably hampered the practical application of this knowledge in everyday living. In preparing this enlightening little volume, the author has attempted to bridge the gap between scientific knowledge and popular performance in the selection and use of foods.

The early chapters of the work are devoted to discussions of the significant advances in the knowledge of nutrition, by decades from 1900 to 1949. A new appreciation of the early work of Atwater, McCollum, and the author is apparent. In the remaining chapters, the practical application of the newer knowledge of nutrition is discussed from the standpoint of economy as well as improved health and well-being. The central theme of the volume is that the 20th century science of nutrition can function not only protectively and correctively, but constructively as well. With respect to the dietary habits of the United States in general, the newer knowledge of nutrition teaches that increased prominence should be given to fruits, vegetables, and milk; while a lower consumption of meats, fats, and sugars would be both economically and nutritionally sound.

In addition to the detailed index, a table of recommended weekly quantities of 11 classes of foods for 19 age, sex, and activity groups; an account of the 1946 World Food Survey; records of actual food consumption; and a selected bibliography are appended.

B. Aubrey Schneider

GENERAL PHYSIOLOGY

SELECTIVE TOXICITY AND ANTIBIOTICS. *Symposia of the Society for Experimental Biology, No. III, Edinburgh, July 1948.*

Academic Press, New York (printed in Great Britain at the University Press, Cambridge). $6.00. viii + 372 pp. + 6 pl.; text ill. 1949.

The volume contains most of the papers read at the symposium indicated in the subtitle. There are stimulating discussions by recognized authorities of approaches to chemotherapy and its bases, of the action of antibiotics, and of various aspects of drug action.

The contents are as follows: The Organic Chemist's Approach to Chemotherapy (W. A. Sexton); The Differential Activity of Certain Anti-Malarial Agents against Protozoa and Bacteria (F. L. Rose); The Study of Enzymes in Relation to Selective Toxicity in Animal Tissues (R. A. Peters); The Design of Bacterial Inhibitors Modelled on Essential Metabolites (H. N. Rydon); Antibiotics Derived from *Bacillus polymyxa* (George Brownlee); The Resins of Hops as Antibiotics (L. R. Bishop); Systemic Insecticidal Properties Induced in Plants by Treatment with Fluorine and Phosphorus Compounds (Hubert Martin); Surface Activity and Permeability as Factors in Drug Action (A. R. Trim and A. E. Alexander); The Permeability of Insect Cuticle (J. E. Webb); Selectivity of Drug Action in Protozoal Blood Infections (E. M. Lourie); Aspects of the Selective Toxicity of Sulphonamides and Other Anti-Metabolite Inhibitors (D. D. Woods and R. H. Nimmo-Smith); The Effects of Long-Chain Fatty Acids on the Growth of *Haemophilus pertussis* and Other Organisms (M. R. Pollock); The Effect of Unsaturated Fatty Acids on Gram-Positive Bacteria (E. Kodicek); The Action of Penicillin on the Assimilation and Utilization of Amino-Acids by Gram-Positive Bacteria (E. F. Gale); Adaptation of Bacteria to Resist Drug Action—with Special Reference to *Bact. lactis aerogenes* (C. N. Hinshelwood); The Significance of Hydrogen-Ion Concentration in the Study of Toxicity (E. W. Simon and G. E. Blackman); The Effects of Phenylcarbamates on the Growth of Higher Plants (G. W. Ivens and G. E. Blackman); The Comparative Toxicity of Phytocidal Substances (G. E. Blackman, K. Holly, and H. A. Roberts); Therapeutic Interference: Some Interpretations (Adrien Albert); Some Effects of Diet on Toxicity—The Influence of Diet on the Induction and Inhibition of Tumours (L. A. Elson); External Metabolites and Ecological Adaptation (C. E. Lucas); and The Production of Antibiotics by Micro-Organisms in Relation to Biological Equilibria in Soil (P. W. Brian).

Leslie Hellerman

BIOPHYSICS

THE ATOM AT WORK.

By Jacob Sacks. Ronald Press Co., New York. $4.00. xii + 327 pp.; ill. 1951.

In this book Sacks tells the story of atomic energy in a readable and understandable way. As background for the later sections, the author first traces the history of scientific theory and research on the elements and their atomic structure. This is a fascinating story in itself, and it is told with a minimum of technical jargon.

The second half of the book shows how radioactive isotopes are being put to use in a variety of peaceful activities—in chemistry, biology, agriculture, and business. There is only one chapter on the military applications of atomic science, and the concluding chapter discusses the possibilities of atomic energy as sources of power.

All in all, this is a good treatment of a highly important subject. Scientists and laymen alike should find it well worth reading.

A. CHAPANIS

APPLIED NUCLEAR PHYSICS. *Second Edition.*

By Ernest Pollard and William L. Davidson. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. x + 352 pp.; ill. 1951.

For the benefit of "the growing army of scientists and engineers who, though not necessarily versed in the language of physics, are using the products of nuclear physics in their respective spheres," the authors have written in rather self-conscious non-technical language. They have covered the essential facts and ideas of nuclear physics in general terms, with a minimum of equations and graphs. Chapters on Technique in Artificial Radioactivity, Artificial Radioactivity in Practice, and Stable Isotopes and Their Applications offer an introduction to tracer experiments. A total of 11 appendices supply more specific information ranging from Dates of Some Important Developments to Elementary Pile Theory, and including a set of laboratory experiments. Newcomers to the field should find Pollard and Davidson's book valuable in providing a first orientation in nuclear physics.

C. D. SWARTZ

PROGRESS IN BIOPHYSICS AND BIOPHYSICAL CHEMISTRY. *Vol. I.*

Edited by J. T. Randall and J. A. V. Butler. Academic Press, New York. $6.80. viii + 279 pp. + 7 pl.; text ill. 1950.

This first volume of a new series of reviews in a borderline field promises well. Indeed, by their selection of material the editors have gone far to establish a definition of the field of biophysics. Selecting but a few topics from "a vast and rather amorphous field of study of which the frontiers and lines of demarcation are anything but well defined," the editors have asked contributors "to write critical reviews in which they discuss the subjects from their own point of view; which may be read with profit by many who are not experts and which will provide scientists with a general survey of recent work and ideas." A judicious balance has been maintained between papers primarily describing new experimental techniques, and papers devoted to the presentation and interpretation of recent observations on biological material.

There are 9 contributions with references, and name and subject indexes. Two papers describe and interpret studies principally of the osmotic and the light-scattering properties of solutions of proteins (H. Gutfrund; G. Oster). K. Rudall reviews evidence, chiefly from x-ray diffraction, regarding the molecular structure of protein, polysaccharide, and polynucleotide chains. A. Engström describes the use of soft x-rays for determining the masses and the elemental composition of cell structures. Two papers deal with optical microscopy: A. F. W. Hughes briefly mentions uses of the phase microscope; and V. Philpot treats in some theoretical detail the detection and measurement of local inhomogeneities in transparent matter. In 2 papers physiological properties of intact tissue are examined. One of these is an essentially descriptive review of the occurrence of steady potential differences between parts of tissues or of cells, and of the variation of these potentials with physiological change and function (E. E. Crane). The second paper, particularly excellent, is by M. G. M. Pryor, and describes the mechanical properties and behavior of fibers and of muscles, and attempts to interpret the latter in terms of the former.

A paper on the tolerance of man for radioactive isotopes rounds out the volume (V. F. Loutit), but the editors wisely and consciously have refrained from increasing the number of reviews of tracer methodology appearing at present.

C. M. CONNELLY

ANALYTICAL ABSORPTION SPECTROSCOPY. *Absorptimetry and Colorimetry.*

Edited by M. G. Mellon. Contributors: L. J. Brady, W. B. Fortune, K. S. Gibson, E. R. Holiday, D. B. Judd, M. L. Moss, R. H. Müller, and E. I. Stearns. John Wiley & Sons, New York; Chapman & Hall, London. $9.00. viii + 618 pp. + 2 pl.; text ill. 1950.

With the introduction of the Beckman spectrophotometer as an accepted part of the equipment of biological laboratories, there has been a need for a comprehensive treatment of the practical considerations necessary for absorption spectroscopy. This book, written by a number of specialists in various fields, treats largely the practical aspects of colorimetry, both visual and photoelectric, and absorption measurements in the ultraviolet, visual, and infra-red regions. Under each of the above headings the reader will find an adequate discussion of the various methods of measurement in common use.

Since absorption spectroscopy is almost entirely an empirical science, the treatment of the physics of the process is considered adequate. Of special interest is a chapter dealing with the various methods of expressing extinction, transmission, or absorption.

L. J. MULLINS

FUNDAMENTALS OF OPTICS. *Second Edition.*

By Francis A. Jenkins and Harvey E. White. McGraw-Hill Book Co., New York, Toronto, and London. $7.00. xii + 647 pp.; ill. 1950.

This is a thorough revision of the authors' *Fundamentals of Physical Optics*, first published in 1937. The text contains 30 chapters divided into three parts: geometrical optics (10 chapters—172 pages), physical optics (19 chapters—428 pages), and quantum optics (1 chapter—16 pages). The section on geometrical optics includes material on plane surfaces, thin and thick lenses, spherical mirrors, the effects of stops, ray tracing, lens aberrations, and optical instruments. Included in the section on physical optics are chapters on interference, diffraction, the electromagnetic spectrum, dispersion, polarization, refraction, magneto-optics, electrooptics and related topics. Each chapter ends with a series of problems, and answers for the even-numbered ones are given in an appendix.

This thorough introduction to optics is intended primarily for students in physics. Research workers in the biological sciences, however, may find the textbook handy as an authoritative guide and reference on matters relating to optics.

A. CHAPANIS

SOURCEBOOK ON ATOMIC ENERGY.

By Samuel Glasstone. D. Van Nostrand Co., New York, Toronto, and London. $2.90. vi + 546 pp.; ill. 1950.

This book should be broadly useful for three reasons: it provides an authoritative source of basic information on atomic energy; the lucidity of the presentation should make the material readily understood by the lay scientist; and the use of the 2-column page with numbered paragraphs makes the book very readable and easy to refer to. Glasstone clearly explains all of the concepts necessary for an over-all understanding of atomic and nuclear physics in the present state of the science. The well organized development of the subject matter, which covers practically every important aspect of nuclear physics from the foundations of the atomic theory through cosmic rays and mesons, includes a brief and illuminating history of each working concept.

The book could serve as a handbook to the biologist interested in the application of tracer techniques to biological problems. The chapter on The Uses of Isotopes discusses the presently available isotopes and their properties, isotopic tracer methods, and several specific applications to biological problems. Nuclear radiations and their interaction with matter are discussed, and the chapter on the Measurement of Radioactivity deals with the best methods of detection known today. A chapter of general interest concerns Radiation Protection and Health Physics.

An evidence of the quality of the editorial work done on this book is the fact that the reviewer was able to locate only one minor typographical error in 525 pages of text. The AEC is to be commended for its choice of author, for the high quality of the text is consistent with Glasstone's reputation. The book would be an important addition to a scientific library.

T. H. BERLIN

BIOCHEMISTRY

PREPARATION OF ORGANIC INTERMEDIATES.

By David Allen Shirley. John Wiley & Sons, New York; Chapman & Hall, London. $6.00 x + 328 pp. 1951.

Those biochemists and biologists who do not consider their chemical shelf limited to items they can buy or borrow will find this volume a useful addition to their organic reference books. Over 500 preparations have been selected from the literature, and it would be unseeming to complain over specific choices of methods or products. Over 30 per cent of the preparations draw on the literature since 1940, but the older literature is by no means neglected, and there is good coverage of the foreign literature as well. Both the typography and proof reading are excellent. These are the commendable features of this book.

In several respects a collection of preparations such as this leaves much to be desired. It neither offers the critical discussion of variants of a specific preparation such as one finds in the more general treatises on organic reactions, nor on the other hand, does it meet the high standards of usefulness set by *Organic Syntheses*. Basically, it is a scissors-and-paste job, the text having been rewritten to a uniform style. It is unfortunate that as a result of this rewriting many details have been omitted, and the directions are even more abbreviated than in the original publication, at least in those preparations the reviewer has checked. If one objects to the paucity of experimental detail given in the majority of original publications, then he will certainly find this collection even less satisfactory.

ROBERT BALLENTINE

CHEMISTRY AND BIOLOGY OF PROTEINS.

By Felix Haurowitz. Academic Press, New York. $5.50. xii + 374 pp.; ill. 1950.

This volume fills a real need, in that it brings together concisely a great deal of work on protein chemistry from a variety of fields, and attempts to orient existing chemical knowledge from a biological point of view. Although the extent to which the biology of proteins, as such, can be developed is at present rather limited, it would seem likely to be a very fruitful direction for the future. The book was designed as "a textbook

which would be understandable to graduate students of chemistry and of the biological sciences." It achieves a well integrated, stimulating and up-to-date treatment. It was naturally not intended to exhaust the subject: thus the life work of a group may be handled in a few paragraphs. But theories are clearly indicated, limitations are explicitly stated, and the type of information which is available is mentioned. Statements are substantiated by quoting the original sources, the citations including 1500 original papers. In spite of its general excellence, contradictions and infelicities of formulation have not been completely avoided. For example, the diagrams in the chapter on protein structure may given an impression to the unwary of a more explicit knowledge of protein stereochemistry than could have been intended, and the text seems a little careless (or should one say ebullient?) in this respect, although the summary of the chapter is meticulous.

Topics discussed are divided as follows: the isolation, purification, hydrolysis and amino acid composition of proteins, 2 chapters; general physical chemistry of proteins, 3 chapters; internal structure of proteins, 1 chapter; 8 chapters on the special characteristics of various proteins classified to a considerable extent on the basis of their biological roles; and 2 concluding chapters, containing a very thought-provoking treatment of the problem of protein biosynthesis, that "cardinal manifestation of life."

EVELYN HOWARD

AMINO ACIDS AND PROTEINS. *Theory, Methods, Application.*

Compiled and edited by David M. Greenberg; 15 contributors. Charles C Thomas, Springfield, Ill. $15.00. x + 950 pp.; ill. 1951.

The Editor states in his preface that "important goals of the researchers on proteins are to determine their chemical composition and structure, to develop improved methods of isolation, to establish their purity, to measure their size and shape, to explore their physical and chemical characteristics, to develop methods for the analysis of their component units and products, and to evaluate the functions and properties of biologically important proteins, and of protein derivatives"; and further "... the presentation of the methods and results of the main channels of effort by which these goals are being achieved, or, at least, approached." These statements accurately describe the contents of the book, for the objectives are well achieved.

Successive chapters are: Properties of Amino Acids (E. E. Howe); Methods for the Determination of Amino Acids (H. S. Olcott); The Preparation of Amino Acids and Polypeptides (S. Archer); The Synthesis of Labeled Alpha-Amino Acids and Polypeptides (J. C. Keed and B. M. Tolbert); Isolation of Amino Acids (M. S. Dunn and L. B. Rockland); Classification, Purification and Isolation of Proteins (H. L. Fevold); Determination of Molecular Size of Proteins (H. P. Lundgren and W. H. Ward); Amphoteric Properties of Amino Acids and Proteins (D. M. Greenberg); Criteria of Purity of Proteins (C. H. Li); Chemical Reactions of Proteins (H. Fraenkel-Conrat); Nutritional Applications of the Amino Acids (H. J. Almquist); The Chemistry of Antibodies (D. H. Campbell and F. Lanni); Biochemical Applications of Proteins and Peptides (D. M. Greenberg); The Metabolism of Amino Acids and Proteins (H. Tarver). Every chapter is written by a capable investigator and at a scholarly level. The statement on the dust jacket that physicians will be especially interested in the discussion of biologically important proteins and their properties because of their special medical problems, should be qualified to its recommendation only to clinicians who are educated to the research level, for the volume will be beyond the comprehension of anyone but a biochemist. The latter will welcome the book with enthusiasm and will be well repaid for studying it.

E. V. MCCOLLUM

THE AMINO ACID COMPOSITION OF PROTEINS AND FOODS. *Enlarged Second Edition.*

By Richard J. Block and Diana Bolling. Charles C Thomas, Springfield, Ill. $10.50. xxxviii + 576 pp. 1951.

This new edition will be welcome by everyone who is interested in the physiology or biochemistry of amino acid and proteins. The introduction is devoted to the history of notable investigations, and to analytical principles. The text presents a compilation of all chemical, electrical, and chromatographic methods for separating and estimating individual amino acids in protein hydrolysates. There is a good discussion of microbiological and enzymic methods for the study of amino acids. A final chapter is on protein and amino acid consumption by people in the United States living under different environmental conditions.

The authors have been successful in making a reference work of great usefulness, which is also entertaining reading. The usefulness of the book could be even further increased by the inclusion, in future editions, of available information concerning the nutritional significance of the optical properties of amino acids and the physiological effects of the ingestion of optical isomers which do not occur in nature; and by the inclusion of a chapter which would contain all available information about the solubilities of individual amino acids and their derivatives in different solvents.

E. V. MCCOLLUM

PLASMA PROTEINS. *Volume II: Symposia on Nutrition of The Robert Gould Research Foundation.*

Edited by John B. Youmans. Charles C Thomas, Springfield, Illinois. $6.50. xviii + 352 pp. + 1 folding table; text ill. 1950.

This volume consists of papers presented at a symposium held in Chicago in September, 1949. The scope is broad: the subject matter ranges from the physicochemical properties of purified protein preparations to such clinical problems as nutritional edema. The presentations are authoritative, and several of the articles contain material not yet published in journals.

In the first paper (Oncley) a brief review is given of methods used by the Harvard group in the fractionation of plasma proteins and of the results of recent studies on β-lipoprotein, β-metal-combining protein and mercaptalbumin. The second paper (Armstrong) presents an informative and relatively simple treatment of the derivations, assumptions, and concepts used to describe the binding of charged and uncharged particles to proteins. London then gives cautious interpretations of data on the rate of incorporation of administered N^{15}-labelled glycine into several protein fractions (electrophoretic separation) in a normal man and a normal woman and in certain disease states such as pernicious anemia or cirrhosis of the liver. Two contributions (Shemin; Frantz and Zamecnik) describe results of the use of C^{14} in the study of amino acid synthesis in vivo and of peptide synthesis in tissue slices. Detailed balance studies on the metabolism of administered plasma proteins or human serum albumin are given by Albright and his collaborators and by Eckhardt and Davidson. Three papers (Chow; Allison; Elman) discuss the relationships of diet, protein stores, and plasma proteins. Other contributions are: plasma protein formation on disease states (Madden); nutritional edema (Gounelle); relation of protein deficiency and temperature to edema (Hegsted and his collaborators); amino acid antagonists (Dittmer); liver proteins (Cohen and Sorof); protein metabolism in relation to resistance to infection (Cannon); immunochemical studies (Heidelberger and Krueger); and adrenal cortex and protein formation and utilization (White and Roberts). The volume is a most useful contribution to knowledge of the plasma proteins.

F. P. CHINARD

ADVANCES IN PROTEIN CHEMISTRY. *Vol. VI, with cumulative subject index for Vols. I–V.*

Edited by M. L. Anson, John T. Edsall, and Kenneth Bailey. Academic Press, New York. $9.50. xii + 549 pp.; ill. 1951.

The enthusiastic reception of each of the volumes of this series attests the widespread interest of industrial chemists and biochemists, medical investigators, and synthetic organic chemists in them as aids to keep abreast of advancing knowledge in the many aspects of protein chemistry. The contributors are among the outstanding experimenters who are studying the varied aspects of this most complex and most versatile of the substances which function in biological phenomena. The present volume maintains the high standards set by previous volumes of the series.

The chapters are: The Electron Microscopy of Macromolecules (Ralph W. G. Wyckoff); Light Scattering in Protein Solutions (Paul Doty and John T. Edsall); Poly-α-amino acids (Ephraim Katchalski); Egg Proteins (H. L. Fevold); Natural and Artificial Iodoproteins (Jean Roche and Raymond Michel); Glutamic Acid and Cerebral Function (Heinrich Waelsch); Cross Linkages in Protein Chemistry (Johan Bjorksten); The Relation of Protein Metabolism to Disease (Herbert Pollack and Seymour L. Halpern). All of these subjects are treated in a scholarly manner.

E. V. MCCOLLUM

FORTSCHRITTE DER CHEMIE ORGANISCHER NATURSTOFFE. (*Progress in the Chemistry of Organic Natural Products—Progrès dans la Chimie des Substances Organiques Naturelles.*) *Volumes V, VI, and VII.*

By L. Zechmeister. Springer-Verlag, Wien. Vol. V: $11.20 (paper), $12.00 (cloth); Vol. VI: $12.50 (paper), $13.30 (cloth); Vol. VII: $12.00 (paper), $12.80 (cloth). Vol. V: viii + 417 pp. Vol. VI: viii + 392 pp.; ill. Vol. VII: viii + 330 pp. 1948; 1950; 1950.

Volume 5 of this series contains reports on carotenoids in marine animals (D. L. Fox), on azulenes, blue and green pigments from plant material (A. J. Haagen-Smith), on the resolution of glycerides from natural fats (T. P. Hilditch), and a review on the enzymatic formation of sugars (W. Z. Hassid and M. Doudoroff). Structural problems of cellulose chemistry are discussed by E. Pacsu, lignin structure by F. E. Brauns, chemistry of toad venoms by V. Deulofeu, and the nature of genes and of cytoplasmic factors by G. W. Beadle. All of these articles are written in English. Volume 6 contains an extensive report on the role of fats in nutrition (H. J. Deuel and S. M. Greenberg), a review on cactus alkaloids (L. Reti), and a particularly interesting review (in French) on the odorous substances and perfumes in animals (E. Lederer). Volume 7 contains authoritative articles of three Swiss scientists: A systematic review on triterpenes (O. Jeger), a similar review on the glycosides of the digitalis group (H. Heusser) both in German, and a report on the active principles of senna (A. Stoll and B. Becker). In the same volume G. Niemann discusses isomers, derivatives, homologs and analogs of thyroxine, and J. W. Williams describes the concentration and purification of antibodies by physical-chemical methods. Most of the articles in these three volumes are written by out-

standing experts. Each article is accompanied by an extensive bibliography, arranged alphabetically and containing the full titles of the quoted papers. Many of the articles contain tables in which an amazing and bewildering number of natural products is systematically arranged. Such tables, e. g., those on triterpenes and glycosides, are extremely useful to the reader and reveal impressively the fascinating play of nature with the molecule of the natural products and with their substituents. The books are very well printed and handsomely bound. Zechmeister is to be congratulated upon the editing of these very valuable volumes.

F. HAUROWITZ

RADIOACTIVE TRACERS IN BIOLOGY. *An Introduction to Tracer Methodology. Second Edition.*

By Martin D. Kamen. Academic Press, New York. $7.50. xiv + 429 pp.; ill. 1951.

This second edition shows an expansion in bulk over the first edition of 52 per cent, or 148 additional pages. This should not be construed as implying an equal expansion in usefulness and merit. For example, the treatment of isotope detection techniques was rather restricted in the first edition, but the essentially similar treatment in the present edition can best be described as primitive. For example, no mention is made of scintillation counters, proportional counters, pulse-ionization counters for alpha particles, or recent advances in ionization chamber measurement, while outmoded techniques and apparatus are described in detail. An almost equal waste of space is the 62 pages devoted to what might be called "nuclear physics." Material in this section has not only been treated much better elsewhere, but the level of the presentation is just about right to be utterly confusing to the uninitiated. An exception to this is the excellent section on the statistics of counting.

The sections devoted to surveys of tracer methodology are certainly more satisfactory than the general introductory sections. There is a lot of useful information as to what has been done with isotopic tracers. Uniquely commendable is Chapter V, on Biochemical Aspects of tracer methodology. This could well be required reading for both the novice and the experienced user of isotopic tracers. In the remaining chapters, it is not quite certain whether one is reading a discussion of the application of tracers or a discussion of biochemical mechanisms. A satisfactory presentation of isotopes in biology and medicine has yet to be written, and this volume, in spite of its pleasant style and format, is not it.

ROBERT BALLENTINE

MEDICINAL CHEMISTRY. *Vol. I. A Series of Reviews Prepared under the Auspices of the Division of Medicinal Chemistry of the American Chemical Society.*

Editor-in-Chief: C. M. Suter. John Wiley & Sons, New York; Chapman & Hall, London. $12.00. viii + 473 pp. 1951.

This is the first volume in a series planned to present reviews in the field of medicinal chemistry. The chief objective has been to include, in each chapter, references to all compounds that have been tested for a particular type of pharmacologic activity. The compounds are listed in tabular form according to groups or chemical series. References are also given to the patent literature. Each chapter further contains a brief discussion of the methods of synthesis and pharmacologic test methods which aid the reader in judging the status of the work in a given area.

This volume fulfills the need for a publication providing comprehensive and systematic summaries of all available data on the biological properties of classes of chemical compounds. As a guide in the synthesis of new drugs and as an aid in the visualization of new structures of pharmacologic merit, the book will be most useful.

The following subjects have been included in this volume: Antithyroid Compounds (George W. Anderson); Antispasmodics: Derivatives of Carboxylic Acids (Robert R. Burtner); Antibiotics from Plants (Chester J. Cavallito); Benzoates and Substituted Benzoates as Local Anesthetics (Thomas P. Carney); Analgesics: Aralkyamines (Edwin J. Fellows and Glenn E. Ullyot); Analgesics: Partial Structures Related to Morphine (John Lee).

C. JELLETT CARR

THE CHEMISTRY OF INDUSTRIAL TOXICOLOGY.

By Hervey B. Elkins. John Wiley & Sons, New York. $5.50. x + 406 pp. 1950.

Elkins' book is on industrial poisons themselves and the industrial processes in which they occur. Most books on this subject are written primarily from the medical point of view. The author suggests that while the control of occupational illness is in the long run a medical problem, the effectiveness of such control is determined by chemical methods. Further, the responsibility for worker protection rests primarily with industry, and the industry's own chemists and engineers are most intimately acquainted with the industrial process. Emphasis has therefore been placed upon the toxic substances themselves rather than on the pathologic effects in humans.

There are 17 chapters. The industrial substances are classified according to chemical composition, e.g., inorganic elements, organic compounds, and natural and industrial products of complex composition. An excellent chapter on air sampling methods should be most useful to the laboratory worker. A chapter on analytical methods describes the procedures used in the laboratory of the Massachusetts Division of Occupational Hygiene, of which the author is chief.

The table on recommended maximum allowable concentrations of toxic substances as gases or vapors, with references, is most useful. A unique section follows this table. The author has presented a discussion of controversial values, and sets forth the currently adopted regulatory standard followed in Massachusetts.

Chapter XV is devoted to fallacies and unsolved problems. Here many erroneous ideas and myths concerning poisoning are explained. For example, the frequently stated hazard of exposing vapors of organic chlorides (chloroform) to open flames yielding phosgene is minimized. Only a few isolated instances could be found where poisoning had resulted from exposure of this sort. In these instances the concentration of the vapors were excessive and intolerable without the flame. Numerous other instances are cited of similar misconceptions.

The book is strictly industrial in approach. Thus, one finds no description of the toxicity of orally ingested compounds or toxic agents absorbed parenterally. A bibliography of 18 pages is included at the end of the volume.

C. JELLEFF CARR

MICROBIOLOGY

ELEMENTS OF BACTERIAL CYTOLOGY. *Second Edition.* *By Georges Knaysi. Comstock Publishing Co., Ithaca, N. Y.* $5.00. xx + 375 pp.; ill. 1951.

This revised and expanded edition will be welcomed by the large group of readers to whom the first edition was profitably addressed. As before, much of the discussion and most of the illustrations derive directly from the author's researches. The orientation is almost exclusively morphological and conservative, in contrast to the broad outlook of Dubos' *The Bacterial Cell*, and to the morphogenetic and cytogenetic speculations of Bisset in *The Cytology and Life History of Bacteria*. For technical reasons, most of the morphological literature has concerned cell walls and membranes, size, shape, flagella, and spores. The most powerful new tool, the electron microscope, extensively applied by the author, has also been most useful in studying these externally obvious structures, and there is a corresponding emphasis in the content of this book. A chapter comprising about a tenth of the book concerns the nucleus. Much of this chapter is devoted to an account of the methodology of staining procedures that is rather critical of the validity of the Feulgen test for DNA, but includes the debatable assertion that "when thymonucleic acid is hydrolyzed with acid the free desoxyribose re-colors the Schiff reagent." However, Knaysi points out that his electron microscope observations have fully vindicated the earlier work based on hydrolyzed material.

The author's professed distrust of indirect (genetic?) evidence is reflected in the absence of any discussion of the genetic functions of the nucleus, in contrast to the chapter devoted entirely to the physiochemical functions of cell membranes. One might suggest that the definition of the nucleus as a carrier of genes is of equal weight with criteria based on chemical constitution or even morphological behavior. It is reminiscent of an earlier era of cytology to read that "the nucleus appears to divide amitotically . . .," and that a "mitosis-like appearance . . . probably results from what seem to be true rapid amitotic divisions in different directions . . .," with no hint of the chaotic consequences to genetic stability which are implied by true amitosis.

Pijper's startling suggestions that flagella may be the result rather than an immediate cause of bacterial motility are discussed at some length. On the other hand, the more plausible observations on methods of bacterial multiplication by fragmentation ("L-forms" of Dienes, Klieberger-Nobel, and Tulasne) are treated very inadequately, and there is, of course, no mention of genetic evidence bearing on bacterial life cycles. The reader looking for an account of Dienes' work is enticed in several places by "See also chapter . . .," but will find only the statement that "there seems to be no valid reason for attributing to these cells a far-reaching biological significance," rather than a critical description of this work. Other subjects which are ignored include ultraviolet microscope studies of bacterial growth cycles (Malmgren and Hedén, 1947) and the intriguing "stars" of *Agrobacterium tumefaciens* and related bacteria.

Technically this edition is much more attractive than its predecessor. However, the illustrations, especially the electron photomicrographs, are of pioneer rather than finished quality, and it is often difficult to follow what the author is pointing out. They have apparently (unavoidably) lost enough in reproduction that their illustrative value is not commensurate with their importance in the development of the author's research. In place of meaningless blurs like Fig. 90, space would better have been reserved for clearer illustrations of bacterial nuclei like those in *The Bacterial Cell*, which the student will still have to consult for this purpose. This book's most successful achievement is a monographic account of the author's impressive contributions to bacterial cytology. Outside these fields, however, the book is already out of balance, and is bound to become more so in pace with the growing integration of genetic and other indirect approaches into general and cytological research in bacteriology.

J. LEDERBERG

BACTERIOLOGY. *5th Edition.* *By Robert E. Buchanan and Estelle D. Buchanan. Macmillan Co., New York.* $6.00. x + 678 pp.; ill. 1951.

At a time when adequate but uninspired textbooks of bacteriology are "a dime a dozen," it is a pleasure to review this very superior textbook, which, although

elementary, contains a great wealth of solid, accurate, well-coordinated information. Even persons well advanced in bacteriology will find it profitable reading for those fields with which they are not familiar. The emphasis is on general bacteriology, but pathogens are very adequately treated, and viruses, yeasts, and molds also receive attention. A minor weakness is that although the names of individual workers are given, they are not always accompanied by dates, so that it is sometimes obscure as to what period in bacteriology the work represents. Nevertheless, the book can be very highly recommended.

WALTER C. TOBIE

PRINCIPLES OF MICROBIOLOGY.

By Charles F. Carter. C. V. Mosby Co., St. Louis. $4.50. 514 pp.; ill. 1951.

The preface of this elementary textbook states that its purpose is primarily to give "a brief general survey of the principles of microbiology" mainly in the medical aspects, but its scope also extends into such fields as allergy and parasitology (flukes, tapeworms, and roundworms). Non-medical aspects are given secondary emphasis. No obvious errors or misstatements were noticed, and the material seemed as soundly presented as can be done in an elementary treatment. It appears (although not explicitly stated) that the author wrote it for his own classes. Since the requirements in different institutions vary, it is only possible to say that those interested should examine the book carefully to see whether it will meet their needs.

WALTER C. TOBIE

TEXTBOOK OF BACTERIOLOGY. *Second Edition.*

By Joseph M. Dougherty and Anthony J. Lamberti. C. V. Mosby Co., St. Louis. $5.75. 491 pp.; ill. 1950.

This book is a premedical or predental textbook for undergraduates, and covers pathogenic microbiology in general rather than bacteriology in the narrow sense. Important statements in the text are generally well supported by references cited in footnotes. Unfortunately, some of the interpretations are not as accurate as they should be. Thus it is stated that "typhus is a disease peculiar to wartime conditions" (p. 289), although the very next page mentions the typhus epidemic which occurred in Ireland during the famine of 1846–47. Tetany seems to be regarded as a synonym for tetanus (p. 293). Other examples could be cited. The book seems to be a fairly good textbook—but not quite up to the best.

WALTER C. TOBIE

LABORATORY GUIDE IN ELEMENTARY MICROBIOLOGY. *2nd Edition.*

By M. S. Marshall. Blakiston Co., Philadelphia and Toronto. $2.25 (paper). xiv + 248 pp. 1951.

The first edition of this manual was published in 1941 as a *Laboratory Guide in Elementary Bacteriology*, and over a thousand alterations in that text are claimed for the present edition. Despite the change in title, the present edition is overwhelmingly bacteriological in the strict sense. Of 96 well organized experiments, spirochaetes, rickettsiae, viruses, yeasts, and molds are treated in only 4, while serology is likewise limited to 4 experiments. This manual will mainly appeal to those who wish a strong but not exclusive emphasis on bacterial physiology and morphology. The book has a flexible cover, and the text is well printed on the left-hand pages, but it is questionable whether the small page size (6 by 9 ins.) allows enough space for the experimental work to be written up on the blank pages on the right.

WALTER C. TOBIE

DIAGNOSTIC BACTÉRIOLOGIQUE DES MYCOBACTÉRIES (*Bacilles Tuberculeux et Para-Tuberculeux*).

By Jean Desbordes; preface by Jean Paraf. Masson & Cie., Paris. 550 fr. (paper). 128 pp. + 1 pl. 1951.

This is a review of recent work on the isolation, staining, culturing, and the determination of pathogenicity and resistance to antibiotics of the tubercle bacilli and related pathogenic forms. The chemical composition of the bacilli is also considered. As well as the French literature, that published in other countries is very adequately covered. The book is a very worthwhile contribution, both as a reference work and for general reading.

WALTER C. TOBIE

HANDBOOK OF BACTERIOLOGY *for Students and Practitioners of Medicine. Sixth Edition.*

By Joseph W. Bigger. Williams & Wilkins Co., Baltimore (printed in Great Britain). $4.50. xvi + 547 pp. + 4 pl.; text ill. 1950.

In his preface to the 6th edition, the author expresses regret for the addition of 80 pages to his text. Considering the tremendous amount of new and important material which has accumulated during the 11 years since the last edition, Bigger appears to have accomplished a prodigious feat of pruning and editing to have incorporated the new material into so few pages.

The book is clearly intended for medical students. Since it has withstood the test of 25 years as a standard textbook in bacteriology, there can hardly be doubt that the author has accomplished his purpose. The

book is neither intended nor recommended for the professional bacteriologist, but there are many "bacteriologists" who could profit by its perusal.

Two chapters have been added and 11 are completely rewritten, with the sections on chemotherapy, viruses and rickettsiae making up most of the bulk of new material. The nomenclature used indicates the author's general acceptance of that in Bergey's *Manual of Determinative Bacteriology*, but the author balks at changing a familiar name for an unfamiliar one merely on the grounds of priority, an attitude which I for one endorse.

The material is presented to the student in the usual fashion. Progressing from a general discussion of bacteria, the preparation and inoculation of culture media, serological techniques, chemotherapy and immunity, he is plunged into a succession of sometimes unrelated microorganisms ending usually at semester's end, with Viruses, Rickettsiae, and pathogenic Protozoa. The book has a definite place on the shelves of those who desire to require no more than a general, practical survey of bacteriology. Students in whom the contents of this book may stimulate a spark of interest will seek more complete works.

ROBERT J. GOODLOW

AN ILLUSTRATED STUDY AID FOR MEDICAL BACTERIOLOGY.

By Walter J. Nungester and Phebe G. Williams. Lithoprinted by Cushing-Malloy, Ann Arbor; [Ulrich's Book Store, Ann Arbor]. $2.60 (paper). viii + 92 pp.; ill. 1950.

This work (in offset printing with wire binder) "represents a continuation of an experiment to determine whether or not a compilation of diagrammatic sketches ... could be useful as a study aid." The left pages contain text or are left blank for the student's notations. The right pages have the sketches and diagrams. "Visual aids" are considered quite the fashionable thing in education these days, but whether graduate students will find a work of this type useful is something for the individual instructor to decide. In any event, the material is sound, and the sketches are clear, although sometimes verging toward the Munro Leaf school of illustration. There is an adequate index.

WALTER C. TOBIE

TECHNIQUES BACTÉRIOLOGIQUES *utilistes pour l'isolement, la détermination et la conservation des microorganismes (bactéries, champignons microscopiques, virus.)*

By Paul Hauduroy. Masson & Cie., Paris. 650 fr. (paper). viii + 167 pp. 1951.

This work consists of an alphabetical arrangement of culture media and of brief descriptions of microbiological procedures. References to the original literature are given in some cases; in other cases this information is lacking. To microbiologists in English-speaking countries it will mainly be of value for occasional reference regarding French techniques and methods.

WALTER C. TOBIE

HANDBOOK OF MEDICAL PROTOZOOLOGY *for Medical Men, Parasitologists and Zoologists.*

By Cecil A. Hoare. Williams & Wilkins Co., Baltimore (Printed in Great Britain). $7.00. xvi + 334 pp. + 3 pl.; text ill. 1950.

Too frequently, as stated by the author in the Preface to this excellent book, "the medical student and the general practitioner have only a superficial acquaintance with the protozoa parasitic in man, based on second-hand information, usually acquired from textbooks of bacteriology or pathology, to which these organisms have been relegated." Although there have been books written on certain segments of protozoology (for example, on malaria and amebiasis) there have been only a few that have attempted to cover the entire field. The notable exception is the 2-volume work of the late C. M. Wenyon published in 1920. It still constitutes one of the honored references of specialists in the field, but due to its comprehensive nature, it is seldom used by the student of medicine. The present publication covers the subject in a relatively concise, readable manner and should do much "to fill a gap in the medical curriculum by providing students and practitioners of medicine with all the essential information regarding the protozoa living in man and the diseases caused by them."

Hoare is an appropriate individual to have undertaken the writing of this book. In addition to being one of the outstanding protozoologists today, he has had the opportunity of being associated with such respected authorities as C. M. Wenyon, Clifford Dobell, and C. J. Hackett. The handbook itself constitutes an expanded version of protozoological lectures given by the author in London to postgraduate students studying for the Diploma of Tropical Medicine. The presentation is admittedly didactic and somewhat dogmatic, but intentionally so in order to avoid confusing the reader who is not specializing in the subject. However, despite the fact that controversial aspects are omitted and no references are given to the original literature, the handbook should prove of considerable value to the students specializing in protozoology and parasitology. Since it emphasizes morphological characteristics and laboratory techniques, it should be of service to clinical pathologists and laboratory workers.

After a general introduction of 3 chapters devoted to the physiology, morphology, ecology, and classification of protozoa, the various organisms are presented in considerable detail. They are grouped into sections entitled Protozoa of the Alimentary and Genital Tract

(amoebae, flagellates, coccidia, ciliates, and coprozoic protozoa), Protozoa of the Blood and of the Reticulo-Endothelial System (leishmania, trypanosomes, and plasmodia), and Parasites of Doubtful Nature (toxoplasma and sarcosporidia). In a separate part of the handbook (6 chapters) the author discusses the diagnostic methods used to detect protozoal infections.

In discussing the various organisms, the host-parasite relations between man and the protozoal parasites are emphasized along with morphology, life history, and diagnosis. Historical considerations and treatments are omitted. The exclusion of matters of clinical treatment may distract from the completeness of the book from the standpoint of practicing physicians. However, since the subject is currently in a rather confused state due to the advent of many new drugs, it was probably wise to omit therapy from the present edition. The handbook is amply supplied with clear illustrations and helpful tables. It possesses a bibliography to related publications and a good index.

M. M. BROOKE

HEALTH AND DISEASE

MEDICAL ENTOMOLOGY, *with Special Reference to the Health and Well-Being of Man and Animals. Fourth Edition.*

By Williams B. Herms. The Macmillan Co., New York. $9.00. xviii + 643 pp.; ill. 1950.

The welcome appearance of the Fourth Edition of this book, which has received widespread and standard use for 35 years, is in itself a high recommendation. During and since World War II there has been a very rapid expansion of knowledge and its application in the field of medical entomology. In my opinion, the latest edition of this book is the only currently available textbook which adequately covers these advances. The most recent data on DDT and other newer insecticides in combatting insect vectors and insect-borne diseases are presented well. Also included are new data on DDT-resistant houseflies, together with time-tempered advice on the importance of environmental sanitation for insect control. Especially outstanding is the continued emphasis on "biology (life history and ecology) as fundamental to rational control and as basic to sound epidemiologic procedures."

This textbook and reference work continues to be heartily recommended by college teachers and by research and applied medical entomologists. The only criticism which might be leveled at it is that it still tends to emphasize local (Californian) data out of proportion; although the insect vectors and diseases in other areas are adequately treated. There are well selected and up-to-date references at the end of each chapter, and the book is well indexed and printed. It is representative of the outstandingly successful career of the author and his many students in the field, and will enjoy a continued, deserved acceptance as a standard textbook and reference on medical entomology.

DALE W. JENKINS

METHODS IN MEDICAL RESEARCH. *Volume 3.*

Editor-in-Chief: Ralph W. Gerard. Year Book Publishers, Chicago. $7.00. xii + 312 pp.; ill. 1950.

METHODS IN MEDICAL RESEARCH. *Volume 4.*

Editor-in-Chief: Maurice B. Visscher. Year Book Publishers, Chicago. $7.00. xiv + 306 pp.; ill. 1951.

The editors of these 2 volumes have been most fortunate in securing the cooperation of a number of competent research workers in the preparation of various articles bearing on selected broad topics, of interest not only to medical men but to biologists in general. It is not possible in a review of this type to do justice either to the topics in general or to the individual papers in particular, except to say that within the limits prescribed the coverage is excellent and the appraisals of research methods critical. This last desideratum has been gained by having at least one expert other than the author go over the manuscript prior to publication. Volume 3 consists of some 30 papers divided between 4 broad topics: the Genetics of Microorganisms (S. E. Luria, Associate Editor), Assay of Neurohumors (J. H. Gaddum), Selected Psychomotor Measurement Methods (Walter R. Miles), and Methods for Study of Peptide Structure (Choh Hao Li). Volume 4 has as its major topics Histochemical Staining Methods (George Gomori), Fluid and Electrolyte Distribution (Louis B. Flexner), Studies on Gastrointestinal Pressures, Innervation and Secretions (J. P. Quigley), and Tissue Culture Methods (C. M. Pomerat).

RESEARCH IN MEDICAL SCIENCE.

Edited by David E. Green and W. Eugene Knox. The Macmillan Company, New York. $6.50. x + 492 pp. 1950.

This book consists of a series of pleasantly written non-technical essays dealing with the present state of our knowledge in a variety of medical subjects. The various chapters were prepared by a number of "hybrid investigators" and are designed primarily for the educated layman, medical student, and clinican. A "hybrid investigator," according to the editors, is a cross between a biologist, chemist, or physicist, on the one hand, and a clinician on the other. An example of Democracy in action!

DAVID B. TYLER

PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION. *By John J. Hanlon. C. V. Mosby Co., St. Louis.* $6.00. 506 pp.; ill. 1950.

The ever-widening field of public health activities and the parallel expenditure of increasingly large sums of public money in the accomplishment of those activities have multiplied the responsibilities and duties of the public health administrator to the point where he must function not only as a competent physician, but as a capable engineer, lawyer, sociologist, economist, efficiency expert, public relations specialist, and fiscal agent as well. The well rounded course in public health administration presents a careful combination of the non-medical aspects of the profession with the broader concepts of public health which embrace the welfare and social betterment of all levels of society. The present textbook derives its excellence from the author's successful attempt at just such a careful combination.

Part I of the volume covers the philosophy and background of the public health movement in the United States. The administrative problems connected with public health organizations, their personnel, their budgets, their legal status, and their relation to government, are considered in Part II of the work. In Part III, the discussions center around the patterns of public health activity in the United States involved in dealing with such special problems as the control of communicable diseases, chronic diseases and adult health, environmental health, maternal and child health, public health nursing, and health education.

For the public health student, teacher, administrator, or field worker, this volume will undoubtedly prove itself to be a valuable source of both inspiration and information. The detailed table of contents, as well as the indices to authors and subjects, will make the volume serve well as a selection for the public health reference shelf.

B. AUBREY SCHNEIDER

PUBLIC HEALTH ENGINEERING. *Volume II.* *By Earle B. Phelps, with Walter D. Tiedeman. John Wiley & Sons, New York; Chapman & Hall, London.* $4.00. viii + 213 pp. + 1 folding chart; text ill. 1950.

Volume I of this textbook was reviewed in *Q.R.B.*, 24: 167 (1949). The present volume is much thinner. It covers the sanitation of milk (4 chapters), shellfish and garbage (1 chapter each), and the general sanitation of food (2 chapters). It contains a large amount of clearly described, well interpreted, up-to-date material. It can be highly recommended as a textbook for advanced students who can be given assignments chapter by chapter. As a reference work it is much less satisfactory, owing to a miserably inadequate index, barely over 2 pages in length and containing only 172 entries.

WALTER C. TOBIE

BIOLOGICAL FOUNDATIONS OF HEALTH EDUCATION. *Proceedings of the Eastern States Health Education Conference, April 1–2, 1948. New York Academy of Medicine.*

Columbia University Press, New York; (Great Britain, Canada, and India) Geoffrey Cumberlege, Oxford University Press, London, Toronto, Bombay, $2.50. viii + 169 pp. 1950.

These published proceedings contain the contributions of 14 people on 4 biological sciences, together with a Foreword by Iago Galdston. Outstanding, eminent scientists ably present modern concepts of nutrition, psychiatry, gerontology, and epidemiology. Whether or not the essays contribute to the "philosophy of positive health education" may be debatable; but the significance of their subject matter can hardly be questioned, nor is anyone likely to doubt that it should have an important place in health education. This stimulating publication should be useful to school teachers, public health workers, and physicians.

HARRIETTE D. VERA

GERMAN AVIATION MEDICINE WORLD WAR II. *Two Volumes.*

Prepared under the auspices of the Surgeon General, U. S. Air Force. U. S. Government Printing Office, Washington. $8.50. Vol. I: viii + 648 pp.; ill. Vol. II: vi + Pp. 649–1302; ill. 1950.

As World War II drew to a close, the United States Air Force in Europe organized and directed a group of experienced flight surgeons in a thorough search for all available information about the accomplishments of German scientists in the field of aviation medicine. Special teams of experts visited nearly every university, laboratory, and military installation where medical research in support of the Luftwaffe had been conducted during the war. The task was a difficult one because many important installations had been damaged or destroyed by bombing, and others had ceased to operate or had been dispersed during the later stages of the war. From this survey grew the idea of having Germany's leading scientists organize the mass of material into a logical, articulate record. The result is this impressive, 2-volume document, written by 56 authors.

The contents are organized into 14 parts: Development and Organization; Aerodynamics and Aviation Medicine; High Altitude: Physical Fundamentals and Methods of Investigation; High Altitude: Physiolog-

ical Fundamentals; High Altitude: Conventional and Pressureized Oxygen Equipment; Acceleration; Vibration; Problems of Heat and Cold; Special Senses: the Eye; Special Senses: Ear and Mechanoreceptors; Selection, Training, and Care of the Flier; Emergency Procedures; Effects of Air Warfare on the Civilian Population; and Blast Effects.

The various parts of the work are not equally represented and, if this is a fair representation of German wartime research, they constitute an interesting sidelight on differences in emphasis between research in Germany and in this country. For example, the sections on high altitude and the eye are especially comprehensive. On the other hand, research on the psychological selection of airmen does not seem to have been pursued with anything like the thoroughness that we saw in this country. These volumes supplement our aeromedical knowledge with that obtained by the Germans, and should be extremely valuable to the aeromedical specialist by opening up new avenues of thought and by serving as a rich source of German references.

A. CHAPANIS

A MANUAL OF ARTIFICIAL RADIOISOTOPE THERAPY.
Edited by Paul F. Hahn. Academic Press, New York. $6.80. x + 310 pp.; ill. 1951.

This is another book on the application of isotopes in medicine to "provide a conveniently available source of practical information to the radiologist, physician, radiobiologist, and biophysicist, and others interested in the isotope field." While a few subjects can be conveniently looked up in this book, they are also available elsewhere. Sixteen authors have contributed 14 brief chapters on phases of isotope usage in medicine. One could use this book as an introductory survey of these topics.

The impression might be gained from the book that there is a large field of application of radioisotopes to diagnosis and treatment in medicine, when in reality it is small. The application of isotopes to medical practice has been greatly overemphasized.

The chapter on Terminology & Standards (Robley D. Evans) is especially important and is one of the best sources of information on this subject. The concept of the roentgen unit is still confusing, however, and much of the chapter is rather technical for the uninitiated. The other chapters are: Introduction to Radiation Therapeutic Problems; Criteria for the Use of Therapeutic Isotopes; Dosimetry of Internally Administered Radioactive Isotopes; Radiophosphorus in the Treatment of Polycythemia Vera and the Leukemias; Radioactive Iodine in the Diagnosis and Treatment of Hyperthyroidism; Radioactive Iodine in the Study and Treatment of Carcinoma of the Thyroid; Radioactive Colloids in the Treatment of Lymphoid-Macrophage Diseases; Tumor Therapy by Direct Infiltration of Radioactive Colloidal Metallic Gold; Radiological Instrumentation in a Therapeutic Program Employing Artificial Radioactive Isotopes; Health Physics; Autoradiography as a Tool in Medical Research; Availability of Isotopes and Means of Procurement; Planning the Radioisotope Program in the Hospital.

FREDERICK W. BARNES, JR.

QUINIDINE IN DISORDERS OF THE HEART.
By Harry Gold. Paul B. Hoeber, New York, N. Y. $2.00. viii + 115 pp. 1950.

Quinidine is effective in reverting and preventing many cardiac arrythmias and ranks with digitalis in importance as a cardiac drug. Possibly all its therapeutic activity may be ascribed to an increase in the refractoriness of the myocardium. Nevertheless because numerous additional effects on the heart and other organs are dangerous or unpleasant, the drug is frequently avoided or used in ineffective amounts. The author discusses the pharmacology and clinical applications of quinidine in a practical fashion. Especially emphasized are the extreme individual variations in therapeutic effectiveness and toxicity of a given dose. The author believes that by avoiding rigid rules and by suiting the techniques of administration to the particular individual, far more effective quinidine therapy can be realized. The combined use of quinidine and digitalis as a routine procedure, to which he is strongly opposed, is thoroughly discussed. The book can be highly recommended on the pharmacological and clinical levels.

E. CONVERSE PEIRCE, 2ND

ALLERGY: FACTS AND FANCIES.
By Samuel M. Feinberg. Harper & Bros., New York. $2.50. xiv + 173 pp. 1951.

Perhaps one of the greatest and most revolutionary changes in the practice of modern medicine from that of our immediate forefathers is in the frank and informative point of view now adopted by the physician toward the patient, and in the importance now attached to the education of the individual in the characteristics of his malady. The previous attitude of "what a patient doesn't know won't hurt him" has been replaced, with few exceptions, by a real desire to acquaint him with the features, symptoms, and intricacies of his malady. It is recognized that usually it is for the well-informed patient that the most successful results in treatment are possible. This would seem to be particularly true in the special area of allergic diseases, as evidenced by the growing number of

volumes written for the layman by numerous specialists in this field.

Among the latest, and it may be said, the best, of these contributions is that of Dr. Samuel Feinberg. Possessed of a flowing, lucid style of writing, he has been quite successful in the attempt to explain the symptoms, causes, and methods of treatment important in the various allergic maladies. Comprehensively, but in a practical, unsensational manner he discusses the several manifestations of clinical allergy, hay fever, bronchial asthma, hives, eczema, headaches, and gastro-intestinal forms of sensitization, and the accepted forms of therapy. In his chapters upon the nonspecific varieties of treatment, the author emphasizes the advantages and the disadvantages of the newer drugs used in allergy. He points out the fact that the antihistaminic preparations do not cure hay fever or asthma, benefit only a fraction of the sufferers taking them, and actually aggravate the symptoms of some. The promise of relief from allergic ailments offered by the most recently discovered hormonal agents, ACTH and cortisone, is analyzed and evaluated.

No attempt is made in this volume to furnish lists of medications applicable to clinical allergic problems, no effort to furnish recipes for the allergic, nor to map in specific detail ways and means by which the victim may escape his allergic indignities and affronts. These measures are left for other types of handbooks upon allergy. The volume is the better for these omissions. Feinberg has been eminently successful in his evident purpose of describing in lay language the facts important to the person with an allergic problem.

W. C. SPAIN

PSYCHOLOGY AND ANIMAL BEHAVIOR

THE PRINCIPLES OF PSYCHOLOGY. *Authorized Edition in two unabridged volumes bound as one. Reprinted by special arrangement with Henry Holt & Co.*

By William James. Dover Publications, New York. $7.50. Vol. I.: xii + 689 pp.; ill. Vol. II: vi + 688 pp.; ill.; index. 1950.

A reprinting of the full edition of William James' *Principles of Psychology* has long been needed. For those who want an abridgment, the attractive volume in the World Publishing Company's "Living Library" (*Q.R.B.*, 24: 266. 1949) will serve, but many will prefer to have this lithoprint of the original. As John Dewey has said, "The book takes rank as a permanent classic like Locke's *Essays* and Hume's *Treatise*."

SOMMARIO DI PSICOLOGIA. *Terza Edizione.*

By Romolo Appicciafuoco; appendices by Luigi Meschieri. Casa Editrice Orsa Maggiore, Roma. L. 420 (paper). 244 pp.; ill. 1949.

This is an elementary treatment of the science of psychology, and will be of most interest to those who would like to compare what is conventionally taught in college courses in the United States with what is taught in Italy. The book is divided into two parts. The first deals with such subjects as attention; stimuli; perception; imagination; association; memory; thinking; the emotions; habit formation; etc. The second part deals with the personality; the influences of heredity; infancy; adolescence; intelligence; learning; selection of profession; and abnormality and mental disease.

PSYCHOLOGY. *Its Principles and Applications. Revised Edition.*

By T. L. Engle. World Book Co., Yonkers-on-Hudson, N. Y. $3.08. xii + 628 pp.; ill. 1950.

Developed from experience in teaching psychology at high school and college levels, this textbook is for general students in the single introductory course. Its simple, clear, and interestingly written treatment of a broad variety of topics makes it suitable for use at the senior level in high school or the general introductory college course. The principal emphases are on the concepts and principles of general psychology, the principles and techniques of efficient learning, and the factors important in personal and social adjustment. Each chapter is preceded by brief pertinent questions, and followed by review questions, a vocabulary list, suggestions for activities or projects, and further readings. Writing and typeface alike are clear and eminently readable, and the over-all effect is further enhanced by a variety of appropriate illustrations and diagrams. The careful thought and experience that has gone into the writing and design of this book will recommend it to numerous teachers and students.

ERLING ENO

HANDBOOK OF PSYCHOLOGICAL RESEARCH ON THE RAT. *An Introduction to Animal Psychology.*

By Norman L. Munn. Houghton Mifflin Co., Boston. $7.50. xxvi + 598 pp.; ill. 1950.

Since its first use in 1894, the rat has been subjected to numerous psychological experiments. Almost every kind of psychological problem that has been studied in man has had its counterpart in research with the rat. Intelligence, emotion, motivation, symbolic power, reasoning, learning, and neurotic and social behavior have all been investigated. Many times the rat has been the subject of choice because experiments called for operations or drug administrations not permissible in man. In other cases, the relative simplicity of the rat's nervous system and its easily controlled life history have made it a desirable research tool.

In his handbook, Munn does the great service of

summarizing this vast literature (about 2500 references). He has done the job well. In the first place, his coverage is excellent, and very few references through the end of 1949 have been omitted. Secondly, Munn presents the research that has been done on the rat in a well-organized set of chapters that cover the major problems of psychology. Of his 10 chapters, 1 is devoted to the care of rats and the technique of experimentation with rats. Another chapter takes up unlearned or instinctual behavior; 2 are devoted to motivation; 1 is on sensory processes; 3 are concerned with conditioning and learning; and 1 with social and abnormal behavior. In addition, a whole chapter is devoted to theories of behavior deriving largely from research with rats.

The third important feature of Munn's book is his careful and critical presentation of the experiments themselves. Most of the experiments are reported in detail, many complete with tables and graphs. Then once the basic facts are set down, Munn gives his interpretations and unites the results of different experiments in a comprehensive whole. Wherever possible, he squares up the results of different experiments and shows clearly where they agree or disagree.

Munn's handbook will be extremely valuable to research workers in psychology and biology who have occasion to use the rat as an experimental subject. It is a scholarly book, quite complete, highly readable, and so well-organized and thoroughly indexed that it is really easy to use.

ELIOT STELLAR

THE PERCEPTION OF THE VISUAL WORLD.
By James J. Gibson; under the editorship of Leonard Carmichael. Houghton Mifflin Co., Boston. $4.00. xiv + 242 pp.; ill. 1950.

The problem of how we perceive the world is an old one for psychologists, physiologists, and physicists. Most current explanations of space perception, in fact, include a heterogeneous collection of ideas which go back to Leonardo da Vinci, Bishop Berkeley, and Helmholtz. In this book, Gibson provides a new and basic analysis of the relations between visual stimuli and the way the world looks. There is, he says, no such thing as a perception of space without the perception of a continuous background surface. Thus the immediate stimuli for space perception are surfaces—surfaces with textures and gradients—and edges. These notions may strike the reader as being immediately obvious, and yet visual scientists seem to have consistently overlooked these important characteristics of the real visual world. The implications of this viewpoint are then elaborated to include much of the current data on space perception.

Gibson's book is neither a history of the problem nor a collection of facts, but rather an attempt to present a unified theoretical background against which to view current theories and data. The text is well written, carefully documented, and extraordinarily well illustrated. This should be required reading for all visual scientists and those who are interested in how we see the world.

A. CHAPANIS

THE STRUCTURE OF HUMAN ABILITIES.
By Philip E. Vernon. John Wiley & Sons, New York; Methuen & Co., London. $2.75. x + 160 pp. 1950.

Factor analysis is a highly complicated statistical procedure for extracting sources of common variance from matrices of correlation coefficients. In psychology, the technique has been used to great advantage in inferring basic abilities or traits, underlying performance on batteries of tests. Vernon's book is a nontechnical discussion of this important technique and a review of the findings which have resulted from its application. Although it is difficult to explain so complex a method in simple mathematical terms, the author has managed to do so extraordinarily well. His critique of the work in this area is especially valuable in helping the reader see the research in its proper perspective. All in all, this book should serve as a useful introduction to this important area of psychological investigation.

A. CHAPANIS

THE TWILIGHT OF THE ABSOLUTE. *The Psychology of Art—Volume III. Bollingen Series XXIV.*
By Andre Malraux; translated by Stuart Gilbert. Pantheon Books, New York (printed in Switzerland). $12.50. 276 pp.; ill. 1950.

This third and concluding volume of *The Psychology of Art*, includes 5 chapters, 3 complementary studies (to be intercalated into the two preceding volumes), 158 indexed illustrations, (20 of them in full color), a bibliographic note, and a general index to the complete 3-volume work. The illustrations are well-selected and beautifully reproduced.

In the main text, the author analyzes the plastic art of, and since, the Reformation. He finds a certain poetic quality common to all great art in spite of its inevitable metamorphosis—fading, fragmentation, and loss of context. Malraux's main concern, however, is with art as a product of particular cultures. With the Reformation, formal religion lost its place of dominance in the culture—the twilight of the absolute—and man became most concerned with conquering the world. Modern culture, Malraux feels, has been slow to produce art masterpieces because art seems to need a basic drive comparable to religion in strength. In this respect, art itself is now taking the place of the religious absolute,

and this attitude means that art in all its forms can be appreciated *per se*. Pluralism characterizes modern art theory and taste in styles. If any one trend in modern art can be called dominant, it is the use of unrealistic forms in which Man replaces Beauty as the criterion.

Malraux obviously has far more than a speaking acquaintaince with a large and well-balanced collection of art work. But his style of writing is always complicated, frequently cryptic, and occasionally obscure. The psychologist of the two reviewers finds it difficult to see how the work acquired its name, but he agrees with his artist co-reviewer that this volume is a worthwhile addition to any art library.

MARIAN R. CHAPANIS & A. CHAPANIS

TEXTBOOK OF ABNORMAL PSYCHOLOGY. *Fourth Edition. By Roy M. Dorcus and G. Wilson Shaffer. The Williams & Wilkins Co., Baltimore.* $5.00. xvi + 717 pp.; ill. 1950.

This is a revised edition of the successful textbook which first appeared in 1934 (*Q.R.B.*, 9: 377. 1934). Outstanding among its many excellent features is a refreshing absence of dry dogmatism. Accurate data and parsimonious conclusions are happily joined with a clear and readable style. The new chapters on psychotherapy and brain damage disorders are highly recommended, for they contain a breadth of perspective that is all too rare.

One flaw stands out against the general excellence of this volume. Fashionable lip service is rendered to levels of function, and the term psychobiological is found at various points. The student will find these are but empty phrases. The 8-page chapter on psychosomatic medicine is completely inadequate, and the whole section on organic psychoses is so out of date that it seems to express contempt for the contributions of medicine and physiology to this field. The work of Selye might at least merit a reference, if only to serve as a model for demonstrating the effects of one level of function on another. The physiology of autonomic responses is scarcely mentioned, and specific examples of psychological-physiological feed-back systems are lacking.

It is to be hoped that these fields will receive more attention when this otherwise excellent textbook is revised again.

ENOCH CALLAWAY III

PSYCHOANALYSIS AND THE SOCIAL SCIENCES. *Volume II.*

Edited by Géza Róheim. International Universities Press, New York. $7.50. 329 pp. 1950.

This is a collection of 9 papers edited by Géza Róheim, an anthropologist and psychoanalyst who might be described as being "very old-line Freud." The papers are uniformly erudite, frequently provocative, and often rather startling.

Roheim uses 46 pages in a defense of the Oedipus Complex as a universal phenomenon. He asserts that no culture, primitive or otherwise, fails to yield evidence in legends and customs to substantiate this. Anthropologists who support another view are dealt with summarily. The final 9 pages of this paper are on "Magic and the Primary Process" and, while very interesting, do not seem to be very closely related to the preceding polemic.

Harry B. Lee, who has thought considerably about the psychoanalytic implications in creative art, has contributed to the volume a very verbose and scholarly work on The Values of Order and Vitality in Art. His thesis seems to be essentially that the artist is not moved to create by any idealized response to beauty, but rather that he is a person who solves unconscious guilt over destructive impulses by the restitution (through his artistic expression) of a lovable object. The observer who gets a deep emotional response to the art form is also, unconsciously, motivated by a similar psychic sequence. While Lee makes a dazzling case for his point of view in terms of logical argument, his position is considerably weakened by a lack of clinical illustrations.

Freud's 'Moses' and Bismarck, an essay by Henry Lowenfeld, forms the section subtitled History. Bismarck is equated with Moses as a leader who was greatly hated during his actual reign but who after his death (actually for Moses, politically for Bismarck) became deified in the minds of his people. Lowenfeld feels that this right-about-face affected the whole character of the German people and made them especially susceptible to the "Chosen People" view that Hitler sold them. This is again a very interesting idea, well written, and carefully (but in this instance not exhaustively) documented.

The 6 other papers are of a similar character. Their main appeal will be to a professionally sophisticated, intellectual audience of those who have not identified themselves with any offshoot of psychoanalytic thinking but who adhere closely to Freud's original postulates.

HELEN ARTHUR

THE PSYCHOANALYTIC STUDY OF THE CHILD. *Volume V. Edited by Ruth S. Eissler and others. International Universities Press, New York.* $7.50. 410 pp. 1950.

This latest volume of *The Psychoanalytic Study of the Child* maintains the high level of interest and quality which has been evident throughout the series. Sound editing has brought together 21 papers which do not overlap but which fit together in dynamic theory so

coherently that the volume has an united effect as well as that produced by the individual studies.

Three papers deal with the problem of doing psychoanalytic work with children via their parents. Perhaps the most dramatic of these is a report by Leo Rangell, who describes how he directed therapy for a child with an anxiety problem through letters to its parents. The correspondence is given verbatim. The author comments on the implications of the parents' reports and on the justification for his own replies.

It is difficult to select one paper to illustrate the calibre of a collection. However, a paper by Kurt Eissler, entitled Ego-psychological Implications of the Psychoanalytic Treatment of Delinquents, seems extremely valuable. Eissler points out how the therapist who works with delinquent youth must modify his classical analytic approach to the patient. Without such modifications, a delinquent is not accessible to treatment since, by definition, such a patient is one who will not endure the inherent frustration in the psychoanalytic process without rebellion, i.e., dropping the whole business. Eissler not only describes the technical points but makes clear why they are necessary in terms of the emotional structure of the delinquent. He suggests that it is the rare psychoanalyst who is skilful with delinquents because the usual therapist cannot afford to identify himself with the delinquent mechanisms. They represent to serious a threat to his own psychic organization.

This yearbook should be required reading for students of psychoanalysis. Students with slight experience may find some of the papers, especially the theoretical ones, demanding. However, their appreciation and understanding of these more intricate contributions will develop, while the clinical papers will be of absorbing interest from the first.

HELEN ARTHUR

SEX QUESTIONS AND ANSWERS. *A Guide to Happy Marriage.*

By Fred Brown and Rudolf T. Kempton; foreword by Abraham Stone. Whittlesey House, McGraw-Hill Book Co., New York, London, and Toronto. $2.95. xvi + 264 pp.; ill. 1950.

The authors base their book on what people want to know about sex, as exemplified by written questions submitted by members of the armed forces in Europe. The questions cover a wide range, and are recognized as filling personal needs. The answers given are stated in non-technical language and are sound in concept. Cultural as well as biological factors are presented, e.g., in the account of the development of a child from infancy to age 6 with progressive repression of its biological urges by cultural forces.

This handbook should be very useful in filling intellectual gaps in sexual knowledge, especially for persons seeking non-technical information.

LOUIS F. CLEARY

AN OUTLINE OF SCIENTIFIC CRIMINOLOGY.

By Nigel Morland. Philosophical Library, New York. $4.75. 287 pp. + 12 pl. 1950.

This book is sure to entertain the ordinary reader who has a casual interest in scientific criminology. It is a well documented treatise on the development of scientific methods in the combat of crime and deals with such topics as fingerprints, identification of individuals, forensic ballistics, medical jurisprudence, forensic chemistry, documentary evidence and forgeries, cryptography and secret writing, microscope and camera, and the applications of scientific criminology. Although there are available more detailed and comprehensive works for the more serious student of criminology, this book undoubtedly should occupy a valuable position in the personal libraries of those concerned with this problem as a source book for reference to much of the literature in the field.

DAVID B. TYLER

THE CRIMINALITY OF WOMEN.

By Otto Pollak. University of Pennsylvania Press, Philadelphia. $3.50. xxii + 180 pp. 1950.

Hardly a moment's introspection is required of any one of us to uncover one of the predominant ambivalent psychological and cultural fixations of our society as regards woman. On the one hand, the female is viewed with suspicion and hostility as a creature "more deadly than the male," dangerous when aroused, a temptress and the incarnation of evil. The prototype of the figure on this side of the coin is the seductive Eve or Lilith or Salomé; but as we examine it closely she becomes transformed into the Witch Woman or the Old Hag. On the other hand and at the same time, we hold woman to be the absolute reverse of evil, an infinitely sweet, innocent, compassionate, and tender vessel of goodness. The montage comprising the aspect now facing us is of the ministering angel and the virginal bride who merge into the Mother.

In criminology the persistence of such an ambivalent attitude about woman has had a distortive effect and has crippled research. Various investigators, blocked in their objectivity by conscious or unconscious subscription to either of these viewpoints, or unaware of the internal conflict engendered by these opposed and equally powerful notions, have shown themselves unable to estimate or understand the female sex in relation to crime. By and large, however, the benign rather than the malignant stereotype has had the greatest influence both on the lay observer and the professional criminologist: it has been a tacit hypothe-

sis in speculation and investigation. This explains why the tendency has been to underestimate the criminality of woman and to maintain a parochial view regarding the amount, extent, variety, range, and quality of her total participation in the all-too-human behavior that is called crime.

Otto Pollak, a sociologist and criminologist with legal and scientific training, has in this book collected and analyzed the available data on female crime. In his search for material he has been assisted by a facility with languages and a very evident determination to refuse to allow himself to be victimized in his careful thinking by the mental hazards of the problem he has chosen to investigate. Thus armed and armored, he has been able to check the material he accumulated against the prevailing beliefs of his professional colleagues. In consequence, he arrives at the first significant and emotionally uncomplicated statement in the literature relative to the criminality of women.

The findings of this research are of more than passing interest and will undoubtedly be discussed widely. Certainly, many authors of textbooks, many teachers, law enforcement officials, and social scientists generally will have to reexamine and reevaluate their own thinking and writing after learning of Pollak's results, published in this volume.

ROBERT LINDNER

INTRODUCTION TO PSYCHOSOMATIC MEDICINE.
By C. Alberto Seguin; foreword by Flanders Dunbar. International Universities Press, New York. $5.00. 320 pp. 1950.

PSYCHOSOMATIC MEDICINE. *Its Principles and Applications.*
By Franz Alexander; with a chapter by Therese Benedek. W. W. Norton & Co., New York. $4.00. 300 pp. 1950.

The principal objections to the general doctrine going under the name of "psychosomatic Medicine" have been set forth in a previous review (*Q.R.B.*, 25: 251, 1950) and what was written there applies equally to the books under consideration here.

Some of the "observations" reported by the enthusiasts of this ancient practice leave one with the impression that they were performed with mirrors. How else can one account for the many instances where they conclude that it is the wagon that is pushing the horse uphill?

The textbook by Sequin attempts to present to the physician in a systematic form the "basic concepts" of the business. The book by Alexander is also concerned with "basic concepts" and presents the results of "systematic investigations." Most fascinating is Alexander's "Specific Dynamic Pattern in Diarrhea," which he sums up as follows:

Frustration of oral dependent longings → oral-aggressive responses → guilt → anxiety → overcompensation for oral aggression by the urge to give (restitution) and to accomplish → inhibition and failure of the effort to give and accomplish → *diarrhea*. (p. 128)

The curious are referred to pages 129–130 for his ideas on constipation.

DAVID B. TYLER

THE PSYCHOLOGY OF MENTAL HEALTH.
By Louis P. Thorpe. The Ronald Press Co., New York. $5.00. xiv + 747 pp. + 2 pl.; text ill. 1950.

This is a volume prepared for the use of college and university courses in mental hygiene, personal adjustment, and the like. Emphasis is placed on the normal or milder deviations from the normal, although excursions are made into the descriptions of the more abnormal states for the purpose of making the milder deviations more understandable. The point of view is eclectic in regard to the statement of different theories concerning any point at issue. The stress is on mental hygiene and what the home, the school, and the community can do to promote it. There is a glossary of technical terms and a very extensive reference list of pertinent contributions. This seems to be a rather valuable book for an introductory course in mental health.

WENDELL MUNCIE

THE COLLECTED PAPERS OF ADOLF MEYER. *Vol. II: Psychiatry.*
Edited by Eunice E. Winters; introduction by Sir David K. Henderson. Johns Hopkins Press, Baltimore. Four Volume Set—$30.00. Vol. II: xx + 674 pp. 1951.

This second volume of the 4-volume set of collected works of Adolf Meyer is devoted to psychiatric contributions. There is an inspired introduction in this volume by David K. Henderson, Meyer's first Chief Resident at the Phipps Psychiatric Clinic, followed then by Meyer's own survey of Thirty-five Years of Psychiatry In The United States and Our Present Outlook, his Presidential address to the American Psychiatric Association, published in 1928. Following this, the book takes up in chronological order his publications from work done in Scotland, Kankakee, Worcester, New York City, and Baltimore. Further portions of the book deal with Early Medical Formulations, Dementia Praecox, Paranoia, Affective Disorders, Psychopathology and Psychodynamics, and ends with a number of reviews which he wrote, and an index. In this volume are drawn together all of his known works dealing with psychiatry proper as differentiated from more sociological and pedagogic studies. Here one will find, throughout, careful atten-

tion to clinical observation, dynamic formulation based not on any antithesis of unconscious processes but on a behavioristic view of the patient's attempts at adjustment to the life factor, both internal and external, and a preference for a melioristic formulation, stressing the things which can be done while admitting the things about which we have no means at hand to offer help. The most famous of his publications have to do with his ideas about dementia praecox and paranoia. These will repay the most careful study, even today almost 50 years later. A perusal of this book would go far toward explaining the attitude and approach of a very distinguished and powerful figure in the development of American psychiatry. It would also help to explain why people of very diverse interests and attitudes could profitably spend time with Adolf Meyer and work in a comfortable relationship with him. He had an openmindedness about most aspects of the field which was no mere cultivated grace but a genuine reflection of his attitude toward the basic problems of our science, and, I might add, toward other disciplines that he was deeply interested in. He was a relativist of the first water.

WENDELL MUNCIE

FREUD: DICTIONARY OF PSYCHOANALYSIS.

Edited by Nandor Fodor and Frank Gaynor, with a preface by Theodor Reik. Philosophical Library, New York. $3.75. xiv + 208 pp. 1950.

Here is a glossary of terms employed in psychoanalysis, defined by and explained in the words of Sigmund Freud. The editors have performed the colossal task of extracting these definitions and descriptions from the myriad books, papers, letters, etc., of the father of psychoanalysis, and in this sense the book is an interesting curiosity—much like the bare bones of a skeleton. Pursuing this analogy, we are left with the same feeling of inadequacy as when we examine a skeleton without surrounding it with muscle, nerve, blood, or the other things that give it life.

It is hard to see of what real use this sort of book is to anyone. The psychiatrist who has read Freud's works, and those that have followed, certainly has no need for it. For the layman, on the other hand, it will do nothing more than give him that little knowledge which is so dangerous. If the editors wished to present the uninformed with a short work designed to enable them to think more intelligently about psychoanalysis, it is extremely doubtful that they have met with any success. The following example (quoted directly from the book) is typical of the way in which a misguided presentation like this can mislead the layman:

Ambition—A—connection is to be found between ambition and urethral erotism.

Should we not be more careful about the technical literature to which we expose the public, especially in fields of this nature?

R. G. GRENELL

HUMAN BIOLOGY

MAN IS A MICROCOSM.

By J. A. V. Butler. Macmillan Co., New York. $3.00. xiv + 162 pp.; ill. 1950.

The English writers possess a facility for stripping a scientific language of its unique and sometimes forbidding jargon without sacrifice of truth or significance, and for conveying to the layman the importance and the meaning of scientific discoveries. They also, perhaps because of their better training in the use of languages, outstrip scientists of other nations in clearness and precision of exposition. J. A. V. Butler, a chemist, upholds this tradition, and his small book on the relation of man to his environment is an excellent example of popular scientific reporting. The contents deal with man as a product of evolution by considering the building materials of life and their progressive organization and complexity up to the point where man has become the first animal to master successfully the use of symbolic language. The matter-of-fact presentation, the excellent use of illustrative points, and the lack of mysticism and sentimentality make this a book to be highly recommended to intelligent readers.

C. P. SWANSON

AN ACTIVE HUMAN BIOLOGY.

By Cyril Bibby; illustrated by Ian T. Morison. Wm. Heinemann, London, Melbourne, and Toronto. 4s. 6d. x + 142 pp. + 4 pl.; text ill. 1950.

This textbook is meant for use in secondary schools. It presents the machinery of the human body and other phases of human biology in a simple but interesting way. Technical terms are at a minimum, but are used when necessary to avoid "diffuseness and circumlocution." An abundance of drawings so simple that each idea is perfectly clear adds much to the teachability. The main topics are: bones and muscles, food, breathing, blood, excretion, sense organs, reproduction, genetics, evolution, and practical uses of biology. The book closes with a list of other books to read, and an index.

One of the best features of the book is the clear presentation of human reproduction, with good illustrations. Another unusually worthwhile feature is the simplification of subject matter, without loss of scientific accuracy.

Each chapter ends with 5 sets of activities, so that the book can be used both as textbook and workbook. Each class is to be divided into 5 groups, each group

to do one set of the activities. Then the groups rotate until each group has done all the activities. This book should interest as well as benefit sudents in secondary schools.

ELLA THEA SMITH

SOCIAL ANTHROPOLOGY. *The Science of Human Society and Culture.*

By J. S. Slotkin. The Macmillan Co., New York. $4.75. xviii + 604 pp. 1950.

Slotkin has produced a quite usable textbook on social anthropology. Like most present anthropologists he does not limit himself to primitive societies, but includes Western society in his analysis. As, unlike many other contemporary anthropologists, he is actually familiar with the research results of historians, economists, and sociologists (and with the results of ethnographers), his procedure is but commendable. He also advantageously differs from many other "social scientists" through his unpretentious, simple, and straightforward presentation. He does not try to fake results by "deep," but essentially empty talk.

In the bulk of his book, Slotkin analyzes the naturalistic, supernaturalistic, esthetic, and mystic attempts to master environment, and describes the basic types of economy, communication, social relations, and social control. Slotkin's method of making a point, and then illustrating it by actual quotations from ethnographic and other relevant sources (like the methods of Sumner and Keller or W. I. Thomas) is essentially sound. A certain danger arises from the author's great learnedness. Sometimes he overloads his text with quotations, especially in the attempt to give in addition to all else a history of social thought by means of further quotations appended as notes at the end of each chapter. A number of cuts in further editions would detract nothing from the value of a substantial, practical, and honest book.

ERWIN H. ACKERKNECHT

HUMAN ECOLOGY. *A Theory of Community Structure.*

By Amos H. Hawley. The Ronald Press Co., New York. $5.00. xvi + 456 pp.; ill. 1950.

This book, compiled with much industry, gives data on the (uneven) distribution of populations over the earth and on population growth and composition. It shows that human groups differentiate functionally and can be classified as corporate (the family, etc.) and categoric (clubs, etc.), as dependent or independent units. It deals furthermore with patterns of the settlement, migration, and expansion of populations and communities. The material collected is that offered in the usual sociology textbook minus a few important items (like class differentiation). The theory offered also resembles that of most sociology textbooks (deep-sounding commonplaces). *Human Ecology* seems thus to be a synonym for sociology, and has for obvious reasons—man being a very peculiar animal—little in common with animal and plant ecology.

ERWIN H. ACKERKNECHT

FUNDAMENTALS OF SOCIOLOGY. *A Situational Analysis.*

By Seba Eldridge, Brewton Berry, Harold A. Gibbard, Noel P. Gist, Carl M. Rosenquist, and Malcolm M. Willey. Thomas Y. Crowell Co., New York. $4.75. xvi + 720 pp.; ill. 1950.

This voluminous book, provided with excellent illustrations and maps, has been planned as a textbook in introductory sociology. The authors have designed it for use as a sort of workbook and place emphasis on the independent study of life problems by the student. It attempts to familiarize the student who takes no other course in the field with cultural relativism, partly using ethnological material.

Seba Eldridge introduces the book with an excellent discussion of primary factors, the hereditary make-up and the all-in-all principle. In the 7th and final part of the book, personality and society are treated by the same author. In Part Two Malcolm M. Willey writes on society and its cultural heritage, and in Part Three Harold A. Gibbard discusses geography, ecology, and the community. The following 2 parts are on population traits and trends and on social interaction and social process, by Carl M. Rosenquist and Noel P. Gist, respectively. Brewton Berry treats social institutions in Part Six.

Despite the fact that this book is no symposium in the usual sense of the word, since from the very outset all the authors shared in planning the project and criticized one another's manuscripts at their various stages of development, it is of varying depth and quality.

ERWIN H. ACKERKNECHT

SOCIOLOGY. *No. 34, Hutchinson's University Library. By W. J. H. Sprott. Longmans, Green & Co., New York; Hutchinson's University Library, London.* $1.60; 7s. 6d. 192 pp. 1950.

This little book gives certain simple notions as to the goals and methods of sociology. It discusses the elementary aspects of political, economic, and social structure and their development. The literature cited is mostly the one fashionable at the moment. Just another book on "social science."

ERWIN H. ACKERKNECHT

GROUP LIFE. *The Nature and Treatment of its Specific Conflicts.*

By Marshall C. Greco; with a list of publications of staff members of the Research Center for Group Dynamics, compiled by Ronald Lippitt. Philosophical Library, New York. $4.75. xvi + 357 pp. 1950.

This book is dedicated to the authors "predecessors": Henri Bergson, Charles Darwin, Sigmund Freud, Paul Janet, Kurt Lewin, and August Weissmann. The author collected case material while doing church work. He favors a non-historical group-life orientation as against the genetic, individualistic approach in the diagnosis and treatment of conflicts. The author seems so fortunate as to know "the purpose of all life" and the answer to a lot of other questions. He is certainly able to produce an almost indigestible terminology which nevertheless does not succeed in hiding his innumerable self-contradictions.

ERWIN H. ACKERKNECHT

SEX IN SOCIAL LIFE.

Edited by Sybil Neville-Rolfe; foreword by Sir Cyril Norwood. W. W. Norton & Co., New York (manufactured in Great Britain). $5.00. 504 pp. + 2 pl.; text ill. 1950.

The aim of this book is to present the various aspects of sex behavior so that the individual may reach his own conclusions to problems in this sphere. To this end 15 contributors have combined their efforts to present widely varied orientations to the problems of childhood, adolescence, marriage, parenthood, and the sex aspects of life through middle-age.

The adequacy of coverage is well represented in the first hundred pages which deal with biology, genetics, and physiology in a thorough but readily understandable manner. The psychological and sociological sections are equally well covered, with especial effort to present the different views upon controversial matters. The subjects are covered quite comprehensively and a surprisingly large amount of sound material is included in so relatively small a book. Much practical information is given, such as the answers to the questions of children and methods of answering them, while pointing out that the real problem in the situation is the attitude of the parents themselves. The editor and contributors are to be commended for their coverage of the subject.

LOUIS F. CLEARY

SEXUAL FREEDOM.

By René Guyon; translated from the French by Eden and Cedar Paul; introduction by Norman Haire. Alfred A. Knopf, New York. $4.50. xiv + 344 pp. 1950.

This book is devoted to the thesis that "sexual acts are legitimate if they are performed under the aegis of science, reason and logic." The prohibitions of sexual acts by Judeo-Christianity are at the root of most problems in present-day living, and the solution is to make such acts legitimate. The author recognizes the impossibility of legislating a prohibition, but he fails to find it contradictory to speak of sexual promiscuity in the same terms. It can be said that this is the work of a man who believes strongly in his cause, and who is willing to further it most vigorously.

LOUIS F. CLEARY

SEXUAL BEHAVIOR IN SOCIETY.

By Alex Comfort. The Viking Press, New York. $2.75. 157 pp. 1950.

The social component of sexual behavior is emphasized, with a short treatment of social development, along with the increased incidence of failure of individual sexual adjustment. A candid survey of the changing problems of courtship, marriage, premarital and extramarital relationships is presented. An interesting view that adolescent petting represents a type of solution to social change in sexual adjustment is presented, with the statement that premarital intercourse is reduced by the practice. The equally objective attitude is taken toward the problem involving sexual deviants that they represent understandable phenomena rather than legal problems.

The author concludes that no grand scheme of cure is available, but that the solution lies in individual and group understanding, which in turn depends on the individuals working in these various fields.

LOUIS F. CLEARY

THE PRACTICE OF SEX EDUCATION. *A Plain Guide for Parents and Teachers.*

By Eustace Chesser and Zoe Dawe. Medical Publications, London. 10s. 6d. 157 pp.; ill. 1945.

Primarily a guide for teaching sex in elementary schools, this book is offered also to parents and others for whom sex education is a problem. Attention is given to the method of teaching as well as the material. In the latter respect the coverage is adequate. Line drawings, suitable for blackboard reproduction are included and should be useful. The small type used makes the reading of the book somewhat uncomfortable.

LOUIS F. CLEARY

GRUNDZÜGE DER VÖLKERBIOLOGIE.

By Ilse Schwidetzsky. Ferdinand Enke, Stuttgart. DM 17.00 (paper); DM 19.60 (cloth). xii + 312 pp.; ill. 1950.

Professor Schwidetzsky's *Biology of Ethnic Groups* discusses the adaptations of human groups to their natural social environment by migration, selection,

and "Siebung" (grouping and regrouping of genetically specialized individuals within the total group). The book is subdivided into three parts: biology of migration, social biology, and the biology of reproduction. Migration biology, the most fanciful and therefore weakest part of the book, deals with the distribution of "Lebensräume," causes of migrations, differential mobility of groups, and selection and "Siebung" through migration. Social biology overlaps with much so-called "human ecology" in this country and analyzes biosocial stratification in space and society, mixture and assimilation, social types, and "city" and "country" types. The author brings in here many new and original points drawn from her own work in Silesia. Propagation biology discusses the choice of partners, increase of population, differential fertility, and selection, very much along the lines followed in this country by the late Raymond Pearl and his school.

The author is very learned, intelligent, and often not without insight into the complexities and pitfalls of her subject, and yet at times her book is appallingly naive and speculative. Far from being a Nazi, she nevertheless subscribes to certain unproven basic assumptions that have marred scientific work in Germany more than anywhere else during the last two decades. She assumes that definite psychological qualities can be ascribed to "races" (and in adopting many of the problematic "races," constructed by her teacher von Eickstaedt, she automatically increases her contradictions). She is inclined to view *all* social events and behavior as basically biological.

Thus, because cattlebreeders live in steppes and *some* of them are asthenic, she constructs the type of "The Europoid asthenic-schizothymic cattlebreeder and migrant," selectively developed by the steppe (just as the "short agriculturalist" is bred by the jungle). The Mongols, of course, ruin this whole "typology."

Germans are said to be "biologically" more migratory than Chinese, because the foreign groups of the former are relatively larger than those of the latter! Such elementary facts as the exclusion of Mongols from immigration into the Western hemisphere or Australia, and religious or climatic limitations to Chinese migration are simply disregarded. Jews are "born traders" (on the "authority" of the economist W. Sombart), criminals are "born" (on the authority of our E. A. Hooton), and E. Huntington's climatic culture hypothesis is readily adopted in spite of its highly speculative character.

These examples are given in order to illustrate my general critical strictures. They do not do justice to the book as a whole, which is full of new and interesting facts and ideas. Those who are able to read critically this uncritical book (written unavoidably in a German that has changed a great deal during the last 3 decades), will draw from it much information and stimulation.

ERWIN H. ACKERKNECHT

RACES. *A Study of the Problems of Race Formation in Man. Publication Number 77, American Lecture Series. By Carleton S. Coon, Stanley M. Garn, and Joseph B. Birdsell; edited by T. D. Stewart, A. H. Schultz, and W. W. Howells. Charles C Thomas, Springfield, Ill.* $3.00. xiv + 153 pp.; ill. 1950.

This is the first small volume in a series of American Lectures in Physical Anthropology, intended as a series of up-to-date, authoritative discussions by experts of various phases of the subject. Coon, Birdsell, and Garn are reasonably well acquainted with the genetic viewpoint upon evolutionary processes, especially speciation and the formation of races; and the introductory section of the book (especially Chapter 2) deals with that aspect. A few errors should be noted, such as the attribution of spontaneous mutations largely to natural radiations like cosmic rays (p. 16), or the definition of genetic drift as "mutation without selection" (p. 20).

It is easy to see, however, that the amalgam is not yet firm, for in the subsequent discussions of Adaptive Changes in the Whole Body, Adaptations to Excesses to Light and Heat under Different Degrees of Humidity, Adaptations to Dry Cold, Adaptations to Cool Damp Cloudiness, Race and Evolutionary Status, and (mysterious title for disease resistance) Race and the Invisible World, the authors speculate freely regarding the selective significance of physical traits with little or no reference to their genetic basis. The final chapter, The Races of the World, defines race as "a somatically unique population or collection of populations"—nothing here about gene frequencies! The classification which follows characterizes briefly 30 "races" within the 6 major "stocks" so frequently called "races" by other anthropologists. The section is illustrated by photographs of one individual of each race. This is probably all that could be done in so small a book; but the discordance between such a procedure, and the definition of a race as a population (which presumes variance in phenotype as well as in gene frequencies) is nowhere noticed.

In short, the book is a useful introduction to the subject, and it contains many stimulating thoughts that may well suggest problems for the population geneticist to work upon—but the treatment is by no means definitive. It reflects clearly the process of change in the patterns of thinking which currently prevails among anthropologists.

BENTLEY GLASS

RACE AND CULTURE.

By Robert Ezra Park. The Free Press, Glencoe, Illinois. $5.00. xxii + 403 pp. 1950.

In this volume, 29 papers by the late R. E. Park have been gathered from the journals and books where they had appeared previously. As a very interesting unpublished autobiographical sketch of Park that pre-

cedes this collection reveals, he was better prepared than perhaps any other American sociologist to deal with race problems. At the beginning of his career he was in close contact with Booker T. Washington; at the end, he taught at Fisk University; between, he travelled in the Far East, South America, and South Africa.

The first essays in this collection deal with culture in the abstract, very much in the vein of contemporary anthropologists, and with some better knowledge of Western society. The following ones deal with race relations, racial prejudice, and Park's most successful creation, "Marginal Man."

It is unavoidable that in such an essay collection there are repetitions on the one hand, gaps on the other. Much which was new, when some of the essays were written about 30 years ago, has by now become commonplace. Much has since then been developed further by pupils of Park, especially by E. Franklin Frazier. Still, as a whole the volume is worthwhile as well as readable.

ERWIN H. ACKERKNECHT

MAN THE TOOL-MAKER. *Second Edition.*

By Kenneth P. Oakley. British Museum (Natural History), London. 2s. 6d. (paper). viii + 98 pp. + 1 folder; text ill. 1950.

See *Q.R.B.*, 26: 120 (1951). A few figures have been improved and new informtion of paleolithic wood spears and the dating of Piltdown man has been incorporated.

YUMAN INDIAN AGRICULTURE. *Primitive Subsistence on the Lower Colorado and Gila Rivers.*

By Edward F. Castetter and Willis H. Bell. University of New Mexico Press, Albuquerque, New Mexico. $6.00. xiv + 274 pp. + 2 pl. + 1 folding map; text ill. 1951.

This is the latest of a series by these authors upon the ethnobiology of the Southwest. All have been excellent and show increasing breadth as the authors have steadily expanded their background in the prehistory, history, and ethnology of their area.

The studies approach being regional monographs. The physical geography of the region, and the archeology, ethnology, and history of early contacts are all reviewed carefully. Much field work was done by the authors, and the pertinent literature was combed for materials bearing on agricultural practices. But, as the subtitle suggests, this is more nearly a study of the total economy of a group of primitive peoples than a narrow agricultural study.

The cultivated crops, maize, teparies (*Phaseolus acutifolius*), pumpkins, gourds, cotton, tobacco, wheat and barley, melons, black-eyed beans, and sunflowers are discussed as to origin, methods of cultivation, preparation for food, and importance in the economy. One of the most interesting sections deals with the semicultivation of seed plants, mostly grasses. The authors advance the interesting hypothesis that these may have preceded maize agriculture in the area.

Wild plant and animal products are also reviewed. Biologists could learn much from study of the frequency of use of devices to reduce bitterness or to remove other undesirable qualities from wild products. There is an excellent summary, which includes among other interesting passages an evaluation of the role of culture in determining why this Egypt of America never brought forth a civilization. The authors conclude that it was due entirely to the cultural attitudes of these tribes.

GEORGE F. CARTER

WHITE SETTLERS AND NATIVE PEOPLES. *An Historical Study of Racial Contacts between English-speaking Whites and Aboriginal Peoples in the United States, Canada, Australia and New Zealand.*

By A. Grenfell Price. Cambridge University Press, London and New York. $5.00. viii + 232 pp. + 32 pl.; text ill. 1950.

A. Grenfell Price, Professor at St. Mark's College in Adelaide, deals with native-white contacts in the United States, Canada, Australia, and New Zealand. This is a historical study and the first comparative analysis of white conquest in different parts of the world. The conquerors in this case were English-speaking hunters, adventurers, convicts, and colonists.

The author has found that in all 4 regions white-native relations evolved in 3 stages. The opening period was that of pioneer invasion on moving frontiers, with decimation of the natives by white diseases and slaughter. The second period, at about the beginning of the 19th century, resulted largely from the great British philanthropic movements, and was characterized by the gathering of natives in often unsuitable reservations. The third period opened slightly before the 1930's, when white governments began to realize the importance of scientific policy and administration. This resulted in recovery and numerical increase of various native tribes.

The achievements of the Roosevelt-Collier "New Day for American Indians" are highly praised by the author, so much that the reader may forget that government policies may change again (as they actually have done already), and that much remains to be done, not only in Australia, which according to Price still treats her natives abominably, but even in the United States.

This relatively short book is well written and of interest to the general reader as well as to historians and socio-anthropologists.

ERWIN H. ACKERKNECHT

BIOMETRY

ONE TWO THREE . . . INFINITY. *Facts and Speculations of Science.*

By George Gamow. The Viking Press, New York. $4.75. xii + 340 pp. + 8 pl.; text ill. 1948.

Gamow has made a reputation as an excellent popularizer of science within his own field. Here he considers numbers. In his peregrinations through space and time he meets with the theory of probability and its applications, among other things, to life itself. A reading of Chapter 9, The Riddle of Life, makes it only too apparent that Gamow would have done better had he found a reliable guide. Schrödinger's excursion into genetics was marked by no notable lapses. Gamow, however, needs considerable instruction. The rest of the book is no doubt very accurate.

BENTLEY GLASS

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

SCIENCE NEWS 19.

Edited by J. L. Cramer. Penguin Books, Baltimore. 35 cents (paper). 144 pp. + 16 pl.; text ill. 1951.

This number includes the following articles of biological interest: Guidance Devices for the Blind (F. S. Cooper); Studying Plants with X-rays; Hormones and Carbohydrate Metabolism (E. Reid); and brief accounts of amoebal transplants, growth control in plants, muscle experiments. More space (10 pp.) is devoted to book reviews and correspondence than in previous issues.

THE NEW PHYSICS. *Talks on Aspects of Science.*

By Sir C. V. Raman. Philosophical Library, New York. $3.75. x + 144 pp. 1951.

There is an increasing need for knowledge on the part of the thinking public concerning the natural world, the impact of scientific thought on philosophy, economics, and politics having never been as great as today. An informed public is a necessary part of our complex civilization. Since, in the end, the tax-paying public supports the research which furthers the progress of science and betters the circumstances of our existence, the scientist has the obligation to keep his plural patron informed of his doings not only that the patron may see how his money is being spent, but also that he may realize how these discoveries will affect his daily life and alter his future activities. Some scientists do this well. Others communicate with their public with difficulty, with reluctance, or with aloofness. Still others maintain, with or without reason, a studied silence. Raman, in this book, meets his obligation with mingled humility and calm assurance, for, great scientist that he is, he is aware of his heritage and secure in his belief in the advancement of science.

The new physics, as defined by Raman, begins with Rontgen's discovery of x-rays, and concerns itself with subatomic units and the laws of their interaction. It is a field in which the author has distinguished himself, his discovery of the Raman Effect having won for him the Nobel Prize in 1930. It is also a field in which the layman can easily become lost, but by adhering to the things which every man knows at first hand: light, color, water, crystals, etc., and by an adroit use of clarifying examples and simple language, Raman in this series of essays has divested modern physics of its mathematical symbolism and revealed some of its more obvious findings and applications to even the casual reader.

C. P. SWANSON

CRYSTAL GROWTH.

By H. E. Buckley. John Wiley & Sons, New York; Chapman & Hall, London. $9.00. xvi + 571 pp.; ill. 1951.

The author is the head of the Crystallography Department at the University of Manchester. He has spent 25 years in investigating various phases of crystal growth. His book, a one-man symposium, covers the subject in its entirety, presenting the author's personal results and referring to several hundred papers and monographs. It is more a compilation than a digest of this huge amount of material. Except for Schubnikov's recent book (in Russian), this work is the only one of its kind available in any language.

Concepts of solution, solubility, and supersolubility are given first, as an introduction to a chapter devoted to the techniques of growing crystals. Theories of growth are presented, with their limitations, in a chronological—and non-committal—way. The phenomena of growth (and of dissolution when conditions are reversed) are thoroughly discussed. Experimental data illustrate the influence of temperature, viscosity, and organic dyes upon habit modifications, dendrite formations, and other peculiar growths. Of interest to biologists are certain references (pages x, 287, 385) to possible physiological uses of impurities to control or inhibit separations of crystals in the form of calculi, rosettes, or "crystal meal," in man, insects, or plants.

The author confuses two fundamental concepts, the "reticular density" and "atomic density" of crystal planes (pp. 122, 219). This is one of the penalties for not distinguishing between a "crystal lattice" (a geometrical concept, an assemblage of points) and "crystal structure" (a physical concept, an assemblage of atoms). Wells' unwarranted objection to the Law of Bravais stems from the same confusion, invoking as it does the "lack of coplanarity of atoms"; this is uncritically quoted in the book (p. 221). In a reference book of this sort, the absence of cross-references from chapter to chapter is regrettable. Possibly it is

due in part to the use of the historical approach. Compensating for this drawback, however, are two carefully prepared indexes, of authors and of subjects, respectively. A bibliography accompanies each chapter. The appendix lists proved habit-modifiers. One of the outstanding features of this work is the excellence of the drawings and plates. The book is printed, on glossy paper, and bound according to the usual high standards of John Wiley & Sons.

W. JUHLE and J. D. H. DONNAY

CYCLES IN WEATHER AND SOLAR ACTIVITY.

By Maxwell O. Johnson. Paradise of the Pacific Press, Honolulu, Hawaii. $5.00. iv + 224 pp.; ill. 1950.

Cycles in Weather and Solar Activity is another attempt to account for apparent cyclic variations in weather by correlating them with similar variations in sunspots or solar radiation. Here, however, the suspected weather cycles are correlated not only with solar variations but also with planetary positions. The author shows that the records of New Haven yearly mean temperatures and rainfall in England correlate reasonably well with yearly relative sunspots and with the synodic periods of certain planets, and then theorizes that planetary positions cause the solar activity. (A synodic period of two planets is the time elapsing between two consecutive syzygies; a syzygy occurs whenever the two planets and the sun are collinear.)

An exhaustive analysis is made of the 39-year record of mean temperatures of Kualapuu, Hawaii. The many indicated cycles are correlated with variations in solar radiation and with various synodic periods. Among the many periodicities found in this record, the one for 92 months is a most remarkable one. Although there seems to be no question of its existence, there is no synodic period with which it will correlate. To establish further the significance of this particular periodicity, the author cites Alter, Clayton, Douglass, and Abbot, all of whom found periodicities of the same length in various records. This calls for some careful search for a proper synodic period. Finally, it is shown that if there existed a planet which would have a 92-month synodic period with Jupiter, this planet would have a sidereal period and a distance from the sun close to that called for by Bode's Law. No such planet is known to exist, but at this distance from the sun there are the asteroids, the two largest of which are Pallas and Ceres. Once it appears that Pallas and Ceres work in combination as a planet in their influence on the sun, it is not difficult to correlate the synodic periods of Pallas-Ceres and the other planets with other cycles in temperature and observed values of the solar constant. In fact, Pallas-Ceres seems to be one of the most important "planets" in its effect on terrestrial weather.

In a chapter on the cause of variations in sunspots, the author discusses the difficulties involved in accounting for the sunspot variations strictly from synodic periods. He suggests that the syzygies suppress the normal solar activity, so that immediately after them, an outburst of sunspots occurs. However, differences in phase and amplitude relationships make the otherwise simple picture extremely complicated. It is finally concluded that electrostatic forces cause variations in solar radiation, and hence weather, while magnetic forces vary the sunspots.

The chapter entitled Long-Range Weather Forecasting is a disappointment, although a thinking reader could hardly expect to find the results of such a study as this of very practical import. Even if all the cyclic relationships found by the author are real in the sense that they will continue in the future just as they have occurred in the past, the application of the cyclic treatment for any one place is a gigantic task. For example, about the most concrete formula offered is one for Kualapuu, consisting of no less than 13 different monthly cycles varying from 11 to 90 months in length. As Johnson admits, this was not successful in predicting Kualapuu's temperatures from 1946 through 1949. Nevertheless, it is suggested that this be tried for other places after extracting the normal annual periodicity. Before doing so, however, one must carefully analyze the past record of the place concerned to get the 13 cycles in phase. This is necessary because not all places will be affected simultaneously by changes in the solar output, the author argues, since it becomes apparent in his study that Kualapuu's temperature changes are first impressed on the Japanese current and arrive at the Hawaiian Islands 3 or 4 years later.

A book such as this can be evaluated only in terms of its basic premise. In the first place, the word "cycle" must be interpreted. On p. 2 the author defines a cycle "as a single completion of a series of events leading to the original condition." And yet, throughout the book there is the inescapable implication that a cycle necessarily recurs ad infinitum, the usual connotation. This is an important distinction, for no one will argue that, given almost any series of meteorological observations, cycles cannot be shown to exist in the *record*, but the question whether they will repeat in the future, and thereby become true cycles, is the one that is debatable. Workers like Johnson correlate the observed cycles in weather with other known and more or less predictable cycles, assume a causative relationship, and then claim to have found a basis for weather prediction.

The causative relationship is the weakest link in the chain. Johnson has assumed from the outset that small increases in solar radiation will necessarily increase the measured temperature at any place on the earth. Meteorologists reading this book will want, ate last, a supporting physical theory on this point.

The electrostatic hypothesis to explain just why the solar output changes during syzygies is not at all satisfying to clinch the correlations. Lacking plausible causative theories, correlations between weather and synodic periods have little, if any, significance. However, Johnson carefully points out that much more work must be done before any real prediction can be achieved along this line of reasoning. The work he seems to have mostly in mind is the cycle-correlation type, although he also recommends study of the electrical and magnetic effects of the planets as well as of sunspots and variations in solar radiation.

Maxwell O. Johnson has had a successful career as an agricultural scientist in the pineapple industry. His contributions in this field are reported to be great. It is unfortunate that he has chosen the frustrating subject of weather cycles to round out an otherwise distinguished performance.

D. J. PORTMAN

PRACTICAL MICROSCOPY. *Second Edition.*

By L. C. Martin and B. K. Johnson. Chemical Publishing Co., Brooklyn. $2.50. x + 124 pp. + 10 pl.; text ill. 1951.

This is a small but handy book designed to give the student of microscopy a working knowledge of the instrument which he is using. The limitations as well as the operation of the various kinds of microscopes are given, and the topics include, in addition to the usual data on the optical microscope, chapters on the phase-contrast, ultraviolet, polarizing, and electron microscopes. The reader will find the book quite useful, for many practical hints are mentioned which will enable the microscopist to employ his instrument to its full capacity.

C. P. SWANSON

SCIENCE RUSSIAN COURSE.

By Maximilian Fourman. Chemical Publishing Co., Brooklyn. $5.00. viii + 274 pp. 1950.

The purpose of this book is to provide individuals who desire to read Russian scientific papers with the "necessary minimum of grammar" and with specimens of scientific Russian for practice. This aim is met by means of 46 pages of grammar and some 180 pages of selections in the fields of physics, chemistry, mathematics, botany, zoology, physiology, and medicine, culled largely from elementary Russian scientific textbooks and from the journal *Priroda* (*Nature*). It is my opinion that the grammatical introduction is totally inadequate to enable a student to read scientific or any other kind of Russian. He would be indeed an extraordinarily gifted language student if he could understand the aspects of the Russian verb by reading the single page of text devoted to it. Furthermore, the Russian words in the vocabulary have not been accented. On the other hand, the Russian text is very interesting. There are articles on the Moon's Radio Echo, A New Method of Cooling Metals under Water, on the Biological Role of Rubber, on Cancer, etc. This book will prove very satisfactory for beginning students who are provided in addition with a good grammar.

ISADORE L. DORDICK

EVERY BOY'S BOOK OF SCIENCE FICTION.

Compiled and edited by Donald A. Wollheim. Frederick Fell, New York. $2.75. 254 pp. 1951.

The pulp trade will generally print anything that smacks of adventure, from illicit love to space ships, and booming sales attest the avidity of the reading public for such escape literature. Occasionally, however, a good story creeps in, with a reasonable plot and a plausible background of scientific information. These the editor has assembled into a single volume, and they cover various spheres of scientific crystal-gazing. Two are on biological subjects, and not particularly entertaining. If one, on the other hand, wishes to give his imagination free rein of an evening, they will serve to pass a few hours.

C. P. SWANSON

CARNEGIE INSTITUTION OF WASHINGTON YEAR BOOK *No. 49, July 1, 1949–June 30, 1950; with Administrative Reports through December 15,1950.*

Carnegie Institution of Washington, Washington, D.C. $1.00 (paper); $1.50 (cloth). xxxvi + 14 pp. + 220 pp. + 7 pl. 1950.

No one who picks up this volume of the *Carnegie Year Book* should miss the 4½ introductory pages of the Report of the President. Books have been written about the nature of science and scientific methods and the qualities of scientists, and have said less. The secret of the continued success of the Carnegie Institution may be found just here. It lies in the wise understanding of the nature of such an enterprise as the support of basic research in science, and in the realization that it is first of all the skilful choice of personnel differing "widely in their interests and methods . . . also in their skill"; and secondly the provision of opportunity rather than any codification and direction of effort from above, which promise results.

Vannevar Bush points out two general approaches: one, to improve the tools of science, and two, to bring to bear a concerted attack upon a specific problem, with all the methods and instrumentalities that will apply or can be created for the purpose. The *49th Year Book* abounds in illustrations of both these approaches. The biological sciences in particular exemplify the value of the concerted attack.

In the Division of Plant Biology physical and chemical methods of a wide variety are being applied to the study of photosynthesis and nitrate reduction. A new device for the transformation and analysis of curves has been developed as the need for such a tool became imperative. Another area of concerted attack is the program in the experimental taxonomy of plants. In this attack the methods of genetics, cytology, ecology, and plant physiology are being brought to bear on fascinating problems of plant evolution. A third area of work is that in paleobotany.

In the Department of Embryology a great variety of problems bearing directly or remotely on the development of the mammalian embryo are in course of investigation. A partial list will suffice to indicate the breadth of the program: biochemical and physiological differentiation during morphogenesis; capillary permeability; enzymatic activities in adult and fetal tissues; uterine contractions in pregnancy and labor; uterine growth in pregnant monkeys; the physiology of the eye; the structure and reactions of blood vessels and lymphatics; sex differences in the pelvis; the human reproductive cycle; etc.

The Department of Genetics has continued its important series of studies on bacterial mutation (Demerec, Witkin, and others), on mutable loci in maize (McClintock), on the organization of the chromosome (Kaufmann and others), and on mouse leukemia (MacDowell and others). A new program is that upon gene action in the axolotl (Dalton and Hall), with methods such as embryonic transplantation, studies of gene dosage effects, and the production of phenocopies being utilized.

The preliminary announcements of work in progress and still unpublished elsewhere make the *Carnegie Year Book* indispensable to workers in any of these fields.

BENTLEY GLASS

FIRST ANNUAL REPORT. *For the Year Ending 30th June, 1949. Commonwealth Scientific and Industrial Research Organization.*

Commonwealth Scientific and Industrial Research Organization, Commonwealth of Australia, Melbourne.

Free upon request (paper). viii + 288 pp. 1949. This very extensive report of scientific work supported and in progress includes many areas of interest to the biologist: Soils; Plants; Animal Health and Production; Nutrition; Sheep; Cattle; Entomology; Fisheries; Food; Forest Products; Wool Textiles; Flax; Wild Life Survey; etc. The Council was established on May 19, 1949, replacing the older Council for Scientific and Industrial Research, and has already an impressive array of activities to support and supervise. It is interesting to consider what might be a comparable governmental organization in the United States, if the National Research Council and the National Science Foundation were united to carry on, in addition to their present duties, all the scientific work of the Department of Agriculture, the Fish and Wildlife Service, Forestry Service, Bureau of Conservation, Bureau of Standards, Atomic Energy Commission, National Institutes of Health, and half a dozen other branches of the government. The growth of the CSIR will be watched with great interest.

THE QUARTERLY REVIEW OF BIOLOGY publishes critical reviews of recent researches in all of the special fields of biological science. The contribution should present a synthesis or digest of the researches and a critical evaluation of them. A mere synopsis of the literature without evaluation or synthesis is not desirable.

Theoretical papers are published occasionally, especially when such papers (1) include a critical synthesis of the literature bearing on the theory and (2) are likely to promote further research in a given field.

The article should be written in concise language, yet in sufficiently non-technical form as to be intelligible not only to specialists in other fields but to the general biologist as well. To this end the article should have a general introduction and a summary which enumerates one by one all of the principal facts and conclusions given in the paper. Interpretative diagrams and schemes are very desirable.

Material ordinarily taking the form of footnotes is set in small print and placed in the text and consequently should be written in a style so as to fit readily into the text. Acknowledgments are printed in the text in small type at the end of the article just preceding the List of Literature. Recent issues of the Quarterly should be examined for style as regards (1) section or subsection headings in the text, (2) literature citations in the text, and (3) List of Literature.

The subjects and authors of articles are selected by the Editors and members of the Advisory Board. Unsolicited articles which conform with the objectives of the Quarterly will be considered for publication.

A feature of the REVIEW is the section dealing with *New Biological Books*. In this department the book literature of different countries in the field of Biology is given prompt notice.

The QUARTERLY REVIEW OF BIOLOGY is issued in March, June, September and December.

Twenty-five reprints, with covers, of articles will be furnished to contributors free of cost. The reprint order blank accompanying galley proofs gives the cost of additional reprints.

Manuscripts may be sent to Dr. B. H. Willier, Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland.

Books for Review may be sent to Dr. H. B. Glass, Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland.

New subscriptions and renewals are entered to begin with the first issue of the current volume. Should any issue of the current volume be out of print at the time the subscription order is received, the pro-rata value of such numbers will be refunded to the subscriber.

Subscriptions should be renewed promptly—To avoid a break in your series, subscriptions should be renewed promptly. The publishers cannot guarantee to supply back issues on belated renewals.

Subscription price: $6.00 United States and countries within the Postal Union; $6.50 countries outside the Postal Union. Single copies will be supplied, when available, at the rate of $1.75 a copy.

Claims for copies lost in the mails must be received within 30 days (domestic).

Changes of address must be received at least two weeks prior to the date of issue.

THE WILLIAMS & WILKINS COMPANY

Publishers of Scientific Books and Periodicals

BALTIMORE, U. S. A.

CONTENTS

"Derived" Activities; Their Causation, Biological Significance, Origin, and Emancipation during Evolution
—*By N. Tinbergen* (1-32)

Plant Hormones in the Development of Fruits
—*By J. P. Nitsch* (33-57)

New Biological Books
Genetics Golden Jubilee
—*By Kenneth W. Cooper* (58-60)

Reviews and Brief Notices (60-138)